SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

SOME RELATIONS BETWEEN PHILOSOPHY AND SCIENCE IN THE FIRST HALF OF THE NINETEENTH CENTURY IN GERMANY[1]

I PRESENT this paper in response to Dr. Councilman's request; and its choice of topics is determined wholly by the instructions that he has given me in asking me to prepare to meet you. It is not for me to judge in what way these hastily prepared notes can be of service to any of you; and as a fact, I confess myself unable to see that they can be of any service whatever to a company of pathologists. I am, of course, profoundly ignorant of pathology. And, as I learn from consulting the sources, the school of scientific men of whom Virchow was the leader felt, at the outset of their great undertaking, in the years before 1850, that philosophy, and, in particular, that what used to be called, in Germany, the *Naturphilosophie*, had formerly been, in the main, profoundly harmful in its influence upon medicine in general, and upon the beginnings of modern pathology in particular, so that one great initial purpose of Virchow and of his allies, during the years before 1848, was to free their young science from whatever was still left of these evil philosophical influences and to make it a true natural science. I not only learn that this was their opinion; but I see, as any student of the history of thought in the nineteenth century must see, that this opinion was in a large measure very well justified. Philosophy, in the first quarter of the nine-

[1] Read at a session of the Pathological Club, of the Harvard Medical School, at the request of Professor W. T. Councilman, President of the Club.

teenth century, in Germany, had done medicine a good deal of harm. The evil influence continued in some sense, although in much diminished degree, into the next decade or so. Yet I am now asked to tell you something about what this movement of thought called the *Naturphilosophie* was, and about what its relations to the natural sciences were up to, say, 1840. But what interest can you take to-day in the story of the evil influence of an enemy that is said indeed to have threatened the cradle of your infant science of modern pathology, but that very early lost all its power to harm. As a fact, the *Naturphilosophie,* viewed as an officially recognized tendency that could possess any strong direct influence in Germany, was very nearly dead before the great days of 1848 came. Since its death, the *Naturphilosophie* has seldom been mentioned by anybody except with contempt. Its later direct and overt influence upon the course of scientific discovery has been nothing. Nothing then that is of any critical importance to the later development of your science seems to be involved in the story that I have been asked to rehearse.

In fact, to speak in a figure, your science of modern pathology, as Virchow nourished it, proved to be a sort of Hercules. In his infancy this Hercules strangled various serpents. One of these is understood to have been so much of the *Naturphilosophie* as a hostile metaphysical power had sent forth to vex medicine, and as still survived to be strangled. Now the original Greek Hercules and his friends were no doubt always fond of telling over, in later years, the story about the strangling of the serpents by the infant. But I have not heard that Hercules and his friends ever put anybody into my present position by asking him to read them a paper on the natural history of snakes. I doubt whether either Hercules or his companions would have found such a paper interesting. Snakes, they would have said, are to be strangled, not studied. The difficulty of my own position in your presence to-night is of course further increased by the fact that I, who study philosophy, doubtless must seem to some of you to be myself a representative, in some sense, of the very generation of vipers in question. My task is therefore hard indeed.

One thing alone has given me the courage to attempt the enterprise. This is the fact that if the direct and easily visible influence of the *Naturphilosophie* upon the later growth of modern science was indeed small, its indirect and relatively invisible influence was probably large, while this latter influence was of a sort which not only may interest you, when I point it out, but which also probably determines some of your own scientific interests even at the present day. I can not show you then that the literal teachings of the *Naturphilosophie* accomplished much of direct moment or of critical importance for the science of that time. But I think that as a fact the spirit of the *Naturphilosophie* did enter, more or less unconsciously, and in ways which were not always evil, into the life of later scientific thinking. I do find that this spirit tends at the present time to be revived, and by some scientific men too,—to be revived, I say, in forms which, as I hope, will prove to be far nobler and more stable than were those which grew up in the first two decades of the nineteenth century. I see moreover that when we try to estimate what this more immortal part of the *Naturphilosophie* meant, we are led to certain considerations about the true spirit and methods of natural science,—to certain questions in which I, as a student of logic, am much interested, and in which, as I believe, you too may take some interest. And so, doubtful as

my task is, it is not wholly hopeless. Perhaps, after all, before I am done I may show you a few facts in which as students of the methods and of the general relations of your own science, you may find something that will be serviceable.

My plan will be this: First I shall sketch for you in the barest outline the external history of the movement called in Germany the *Naturphilosophie*—its rise, its brief success, its inglorious downfall and end. I shall lay stress, of course, on its relations to natural science, such as they were. Then, secondly, I shall try to indicate to you what the deeper ideas were which lay behind and beneath all the vanities and the excesses of the *Naturphilosophen*. Thirdly, I shall try to indicate how these deeper ideas, despite the vanishing of the *Naturphilosophie* from the scene, indirectly but seriously influenced the course of the later development of natural science in the nineteenth century, and how these ideas seem to be traceable even in some aspects of the history of your own science, so far as those aspects are visible to the layman. Fourthly, and lastly, I shall present to you the question whether some light is not thrown upon the logic of natural science, upon the ideals and methods of scientific work, by considering the relation between those deeper ideas that inspired the *Naturphilosophie* and the actual growth of scientific investigation in the years since 1840.

I

First then, for the purely external, and the least interesting aspect of our story.

At the opening of the nineteenth century, a very notable philosophical movement was under way in the thought of Germany. This movement had been initiated, in the years about and after 1780, by Kant—himself a man of considerable training in the physical sciences of his time, of considerable acquaintance also with the empirical study of human nature, and of a very sane, sober and critical judgment. Kant intended, amongst other things, to define and to formulate a philosophy of the principles and methods of the natural sciences. He succeeded so well that his ideas are still of great importance for any serious student of logic and of the theory of knowledge; and their value for such a student will not soon be exhausted.

But Kant's influence was not confined to the study of the foundations and methods of science. He still more immediately influenced his time with regard to questions of ethics, of theology, and of the more fundamental religious issues of life generally. As a fact, his age—which soon became the age of the French Revolution, and of the great classical literature of Germany, was in his country an age of the humanities, rather than of the natural sciences. His influence was therefore felt, at the moment, much more in the direction of the humanities, than in any other way. The philosophical movement to which he gave rise, accordingly, soon grew beyond what he had intended, and concerned itself with a constructive creation of idealistic systems of thought such as he himself considered unjustifiable. And in these systems, about and after the year 1800, the principal stress was laid upon what were essentially ethical and theological issues. The post-Kantian idealists conceived their philosophy as a sort of substitute for all that traditional religion had so far meant for the world, or at least as a discovery of the absolute rational warrant for new and higher stages of the religious consciousness. So a great part of their work had no direct relation to the business of natural science.

It came to pass, however, just before 1800, that one of the most enthusiastic of these young idealists, namely, Friedrich

Wilhelm Joseph Schelling, was led by motives, which I need not pause here to portray, to turn a large share of his attention to an effort to absorb into his absolute system an organized theory of the nature and meaning of the physical universe. Schelling called this portion of his doctrine the "Philosophy of Nature." That special use of the term *Naturphilosophie* with which we are here concerned was thus due to Schelling. It meant an interpretation of nature in the light of the principles of an idealistic philosophy.

Of Schelling's genuine significance as a philosopher this is not the place to speak. Of the man himself, a very general characterization is more possible. In 1800 he was twenty-five years of age. Yet he was already a professor at the University of Jena, to which he had been called in 1798 by Goethe's recommendation; and he was also, before the close of the eighteenth century, a celebrated man and a prolific author. He was, in this his decidedly wonderful youth, an intensely restless genius, all aglow with brilliant and often with very genuinely significant ideas—a man of a tropical intellectual fecundity, but also of dangerous self-confidence. In polemic he was merciless, in expression enormously complex, in literary form strangely unequal. The luminous and the hopelessly opaque stand side by side in his books in the strangest contrast. His industry was enormous, his sincerity unquestionable, his real power unmistakable, his waywardness exasperating, his frequent obscurity unpardonable, his contemporary influence vast, but most of his work, despite its frequent value, still far too unstable. He inspired a generation of young men, but did them little good that was at once direct and permanent. He wrote down some thoughts that deserve to be remembered for all time, yet so affected his contemporaries that the best of them later turned almost wholly away from him. He thus proved, in the long run, to be an irritant rather than an organizing power. His work was often like that of a whirlwind in the world of thought, disturbing, cloud-enshrouded, momentous, but dissatisfying. After 1803 he left Jena, lived long in South Germany, lost his place for many years as a leader of the national thought, passed through various periods of further philosophical development, lived to a stately and ineffective old age, came once more in 1841 into a brief prominence as a public lecturer in Berlin, but then, retiring yet again from public notice, died in 1854, nearly eighty years old. His published works number fourteen volumes octavo.

For our present purposes, in order to sketch the youthful Schelling's *Naturphilosophie* as he formulated it in the years about 1800, I shall content myself with the following: Certain reasons which I need not now try to portray, but which, in view of the history of human thought, are, to say the least, strictly intelligible reasons and which are in their true interpretation, as I myself think, quite defensible reasons, led Schelling to hold, as many philosophers had held before him, that the universe in which we live is in its inmost nature a single organized unity. In other words, Schelling was what you nowadays often hear called a monist. Moreover, Schelling was confident that philosophy, as it was in his time, was prepared to give a new and final interpretation of this unity of things. Now an account of the unity of the world would of course undertake to consider the problems of theology, of ethics, and of the philosophy of mind. But this same philosophical account, as Schelling held, would also include a discussion of the nature, the unity and the meaning, of the physical world. Such an account—such a philosophical theory of nature—as Schelling often and expressly

maintained, would be, in one aspect, an *a priori* theory, that is, it would be based upon the general character of our own knowledge of nature, and upon the demands which are made by our reason. For, as Schelling held, truth can not be accepted by us, unless we can recognize it as in some sense our own truth, the expression of our own rational demands. Great stress was thus laid, by the philosopher, upon the share which our own self-conscious insight has in defining for us the nature of things. It would be a mistake, however, to suppose that the youthful Schelling, even with all his enthusiasm, actually ventured to attempt to spin all the contents of his *Naturphilosophie* out of his bare and unaided inner consciousness. He was both ignorant and contemptuous of the well-disciplined procedure of the more abstruse experimental sciences; but he was not ignorant of the broader results which the natural sciences of his time reported; and he took considerable interest in these results. Moreover he was, in a way, an enthusiastic although very undisciplined observer of nature. His defect was thus not like the defect of a modern christian scientist who simply turns away from natural phenomena, and denying that they mean anything but mortal error, does indeed get a theory of nature only by means of deliberately ignoring natural truth. Schelling's defect was rather that of an esthetically minded enthusiast who revels in the study of a great variety of natural phenomena, but who undertakes to interpret these phenomena by means of personal intuitions. Meanwhile these intuitions themselves were, with Schelling, by no means those of a mere child, or of a savage, but of a wayward yet highly cultivated young man of the close of the eighteenth century. They were intuitions which presupposed, and undertook to interpret, the results of much miscellaneous reading, and of a good deal of undisciplined observation on Schelling's part relating to physical, chemical and biological facts and theories. You can not doubt Schelling's capricious but extensive industry in the study of nature. His fault lay in his self-assurance, in his impatience, and in his determination to tell nature at once upon meeting her precisely what she meant. Amongst his favorite classes of phenomena, about which he read and speculated, were those of electricity and magnetism, of chemical affinity, so far as these phenomena were then known, and of organic development. He was indeed far beyond the uncultivated fashions of interpretation which we know so well in ordinary cranks. Yet much of his work was as vain as circle-squaring in its actually resulting relation to any concrete business of natural science. Schelling had amongst other things a considerable and a somewhat mischievous interest in medicine. What now is called psychical research was a favorite occupation of the time; and that too won a good deal of Schelling's attention. In 1806, after Schelling had left Jena, he began to publish, in union with a friend and partial disciple of his, A. F. Marcus, a periodical called *Jahrbücher der Medicin als Wissenschaft*. Of this periodical three volumes appeared at Tübingen, the third and last in 1808. The articles to be found in it include an extensive series of aphorisms on the *Naturphilosophie* by Schelling, papers on animal magnetism by Schelling's brother (himself a physician), essays on the application of various metals (iron, mercury) in medicine by Marcus, papers on the relation of botany to medicine by Steffens, on inflammation by Marcus, and so on.

As the mention of this journal shows you, the *Naturphilosophie* of Schelling had from the first the tendency not to remain the expression of the individual philosopher, but

to form a school, to apply itself to various arts and sciences, to publish in journals special researches—in brief, to assume the outward seeming of a progressive and humane science. Ere long it had representatives, exemplifying various grades of discipleship, in academic chairs in Germany. To the young men who fell under its influence it sometimes meant, no doubt, a chance simply to spare themselves serious effort in their study of natural science. A young medical man might learn phrases instead of making laborious observations. On the other hand, one can not accuse most of the prominent *Naturphilosophen* of laziness. They were for the most part very industrious writers and thinkers and some of them did a great deal of empirical investigation. Their enthusiasm was due to their belief that they had found a general way of interpreting the results of natural science so far as these were known to them. As the age was one when, in Germany, the teaching of the natural sciences had been for some time at a low ebb in the German universities, there is something to say for the view that the whole movement of the *Naturphilosophie* was the first crude and eager beginning of a new era of scientific activity in that land, rather than a hindrance to an already developed scientific movement. For the rest, the fact that results of natural science, obtained for the most part outside of Germany, had suggested to that period new and attractive ideas, which seemed to promise surprising generalizations—this fact, I say, serves in some measure to excuse the enthusiasm of the *Naturphilosophen*. The discovery of galvanism, the general progress of the knowledge of electricity, the beginnings of chemistry, the various beginnings of discovery in the biological sciences—all these things constituted fascinating temptations to overhasty generalization. To these temptations the *Naturphilosophen* fell a prey. As to the precise extent to which the *Naturphilosophie* directly affected the scientific thought of Germany, mere statistics may show something. Three only of the philosophers who were especially identified with the movement are now remembered as of note in the history of philosophy. These are Schelling himself; the Norwegian Steffens, who mostly lived and wrote in Germany, and was professor in Halle and Berlin; and Oken, the one amongst the *Naturphilosophen* who had the most serious and varied training in natural science, and the most direct influence upon important scientific activities outside of philosophy. Oken instituted, for instance, the yearly gatherings of the German *Naturforscher* and *Aertzte*. In addition to these men, Ueberweg, in his "History of Philosophy," finds it worth while to mention, amongst the followers and allies of Schelling, ten different men who may be said to have been in the main *Naturphilosophen*. None of these are of great historical importance from the point of view of later thought, although they are men of decidedly various degrees of power and service in their time. Some philosophers of the first rank, such as Hegel, who also belong to that age, and contributed to some form of the *Naturphilosophie*, are nevertheless not to be reckoned among the *Naturphilosophen* proper, because their main work and influence lay elsewhere. Hegel's *Naturphilosophie* was only a small part of that thinker's encyclopedic system, and that part of his system contributed little to his historical influence.

If one turns to the directer influence of the *Naturphilosophie* upon the more special sciences, I find that Siegmund Günther in his "Geschichte der anorganischen Naturwissenschaften im 19ten Jahrhundert," mentions only five or six names as those of men sufficiently important on the side of

their relations to natural science to need consideration from his point of view as representatives of the *Naturphilosophie*. On the other hand, F. C. Müller, in his "Geschichte d. organischen Wissenschaften im 19ten Jahrhundert," beginning his mention of the *Naturphilosophen* who influenced the organic sciences with Schelling and Oken, adds thereupon the names of fifteen others whom he classes as "*Bedeutendste medicinische Naturphilosophen.*" Of these Steffens and Marcus have already been mentioned. The rest are described as men of various caliber—some of them medical authors, most of them professors—some of them contributors of important special researches in medicine—others less fruitful. To the most important belong Kielmeyer, who greatly influenced some portions of the work of his contemporary Cuvier, and Ignatius Döllinger, who was a center of great importance in medical teaching at Würzburg. Hirsch, in his "History of Medicine in Germany," enumerates a still somewhat larger list of more or less pronounced *Naturphilosophen* who deserve mention from the medical point of view—altogether more than a score. Hirsch, J. C. Müller and Haeser, in his "Geschichte der Medicin," agree in giving much the same impression of the activities of these men—several of them special investigators of much industry and productivity, several of them persons who gradually worked themselves free from the formulas of their philosophy—all of them injured, in the eyes of later science, by a tendency to constructive formulas of an unjustifiable type. Where they did good work, in the general biological sciences, their work was usually, as I gather, in relation to some aspect of the study of the evolution and the comparative morphology of living forms.

It is customary to say that these *Naturphilosophen* stood altogether in the way of the new awakening of the natural sciences in Germany. But as I have already said, while philosophy no doubt did medicine mischief in those days, it is still at least partly true that these *Naturphilosophen* constituted a transition from a time of scientific stagnation to one of great activity. They must be judged, accordingly, as beginners rather than as mere mischief makers. Their most characteristic work falls before 1820. Before 1830 the school had been led, in their relations to pure philosophy, by the official success of Hegel's doctrine at Berlin, to occupy a less notable place as a subordinate part of a philosophical movement in which, for Hegel himself, religious, political, and ethical issues were more important than were those of the interpretation of nature. After Hegel's death, in 1831, the movement of the *Naturphilosophie* ere long began to lose the sort of moral support that his type of constructive idealism could give to it. For the Hegelian school became absorbed in religious and in political conflicts, split up into parties, and soon lost whatever touch it had possessed with the progress of natural science. The consequence was that after 1830, the *Naturphilosophie*, neglected by the philosophers themselves, generally denounced by the academic leaders of natural science, and little defended by its own now aging followers, rapidly lost its hold upon the public. Virchow still regarded it as a danger until 1848. After 1848 he too speaks of it as altogether dead.

II

So much for the external history of the movement. But now for some words as to its leading ideas and as to its indirect influence.

An idea may be advanced by a man who has no sufficient logical right to hold it. That idea may later become fruitful in the

minds of wiser men. The originator is then often either forgotten or condemned. But the idea is none the less potent and valuable. Now amongst the leading ideas of the *Naturphilosophie* were a number which have since proved to be of no small importance in the sciences. The first of these ideas is a vague and an ancient, but a powerful idea, which the *Naturphilosophie* simply translated into more modern terms, and so prepared, as it were, for use in the new century. This is the idea that all science must strive to be one, that special research must be governed, in the long run, by the aim to bring truth into unity, and that unity is always beneath all sorts of plurality, as the basis and the meaning thereof.

I have said that this idea is vague. It always remains vague until you discover, in some field of knowledge, in what sense it is true. Then it always appears very luminous, and you rejoice in it. I have said that this idea of the essential unity of truth is ancient. The Greeks began with it. The sages and the saints lived and died for the sake of it. The church tried to secure its recognition by means of a catholic creed. The medieval mystics revelled in it. Yet many heretics also gloried in it as their own peculiar possession, and Giordano Bruno was burned for the sake of it. The modern philosophers renewed the idea. Spinoza reared a beautiful monument of thought in its honor. The *Naturphilosophen* spent their strength in proclaiming it. And since their time modern science, in the later theory of energy, in the doctrine of evolution, in various other ways which I need not enumerate, has illustrated it with unexpected brilliancy, and with marvelous precision.

Now this idea, that the unity of the truth is deeper than is even the most baffling variety of phenomena—what does this idea mean? In what sense is it a leading idea of science as well as of religion and philosophy? To this question it is easy to answer that by the unity of truth one means nothing that one would have a right to assert of any world that is foreign to human thought. One means only that man always strives and must strive for his own rational purposes, to get his ideas into some sort of rational connection, and to view them as a system. The demand that truth shall hang together and be one whole is man's demand. His reason restlessly searches for such unity, and is discontented until the quest succeeds. This is indeed the fact. Man's reason demands that man's experience shall be viewed as a connected whole. Well—this, apart from their obscurities, is precisely what the *Naturphilosophen* taught. Since they were idealists, they did not view the world as anything foreign to the human reason. Hence they founded their interpretation of the unity of things expressly upon the needs and the interpretation of man's own rational nature. Vague as their thinking was, it did therefore express a decidedly sound consciousness of the motives that lead us to seek for unity in the world of scientific truth. Now you may rightly say that the *Naturphilosophen* had no right to prescribe to nature, as they did, just how her laws should be interpreted even before they had been adequately observed. But, on the other hand, men generally do not find until they eagerly seek. The *Naturphilosophen* set their countrymen eagerly seeking for unity in nature. They specialized the vaguer ancient idea of unity by giving it conscious relations to the newer fields of natural science. I am tolerably certain that the eager search thus begun had a very real, even if a mainly indirect, influence upon the successful prosecution of the search which so soon followed the decay of the *Naturphilosophie* itself. I

shall show you in a moment a little evidence bearing upon the subject.

The second of the leading ideas of the *Naturphilosophie* related to the special form which they conceived the unity of natural truth to take. They were very fond of speculating upon the unity of what we now call the various forms of natural energy. Light, electricity, magnetism, the vital processes, these, they were disposed to insist, were forms or stages of a single, all pervasive natural process. Now, nobody with the least sense for logical connections can for a moment confuse the modern doctrine of energy, with its exactness of quantitative definitions and relations, with the vaguely conceived teleological unity that the *Naturphilosophen* ascribed to the natural world. On the other hand, nobody who considers fairly the history of the topic can fail to see that the modern doctrine of energy had two very distinct, but marvelously related sources. One of these sources was the state of modern technological knowledge in the early part of the nineteenth century. The other source is the state of general philosophy in the same period. The modern doctrine of energy is due, I insist, to a curious and unintended alliance between the interests of the engineers and the ideas of the philosophers. I shall recur to this topic again very soon. For the rest, one may say that a conception like that of the modern doctrine of energy is not found until one learns to look for it in the right spirit. The *Naturphilosophie* had its indirect part in creating this right spirit with which later men, far better equipped than were the *Naturphilosophen* themselves, looked for the truth which took form in the doctrine of energy.

Thirdly, the *Naturphilosophie* had another leading idea which more directly concerns your own science. This was the idea of comprehending organic products by conceiving them as results or at any rate as stages, of a process which has the form of an evolution. The more modern evolutionary ideas are prefigured in all sorts of vaguer and of more concrete forms by the various *Naturphilosophen,* from Schelling onwards. Oken comes nearest of all of the group to using categories like those of a modern evolutionist. When, in the generation that was in its early prime in the thirties and the forties, various naturalists made a systematic method of appealing to a study of the embryology, of the early stages, of any natural form, as a principal means of understanding its mature structure, they were following a leading idea which was again in one sense a very ancient idea, since the Greeks already possessed cruder forms of this idea. But, on the other hand, this leading idea had assumed, by the time in question, shapes which it could not have assumed had not the *Naturphilosophen* preceded. Herein lay, in all probability, one of the most substantial of their indirect influences upon the course of later science. In the minds of the *Naturphilosophen,* this idea of conceiving organic nature as a process to be understood in evolutionary, or at least in quasi-evolutionary ways, was a direct result of their philosophical principles. They not only possesed the idea; but they applied it in ways which brought it into relations with modern science. The predominance of *Entwickelungsgeschichte* in all the later studies of German science in the nineteenth century is in all probability largely influenced by the indirect effects of the *Naturphilosophie.*

As you see, no one of the three leading ideas just mentioned can be regarded as originated by the *Naturphilosophie.* Each is, in some sense and in some degree, a very old idea. But the interest of the *Naturphilosophie* lies in the fact that just be-

cause of its enthusiastic efforts to reform and to conquer the natural science of its time, it gave to these old ideas a new turn, a new setting, a new application, a new translation. The *Naturphilosophie* supposed itself to be interpreting the world of natural science in the light of its own philosophical ideas. As a fact, it was rather interpreting certain ancient philosophical ideas in the light of the facts which it learned in the course of its rather undisciplined study of science. But by thus reshaping the old ideas into modern forms, it prepared them to become leading ideas for a later generation of serious scientific workers. For, when it thus translated them into more modern terms, it rendered them comprehensible and attractive to men of the new time. It made them seem portentous to its own generation. The *Naturphilosophie* itself was soon dead, and mouldering in the grave. These leading ideas, its soul, went marching on.

III

I have now enumerated three of the leading ideas of the *Naturphilosophie*. You will properly ask what evidence there is that leading ideas derived from such sources actually influenced any serious scientific workers of a later period.

And so I come, hereupon, to a very inadequate report of an interesting class of phenomena, whose significance the historians of the nineteenth century science seem to me to have somewhat neglected. Let me call your attention to the following biographical facts regarding a number of notable scientific men.

Johannes Müller, the physiologist, born in 1801, studied from 1819 to 1822 in Bonn. His most notable teachers in medicine were *Naturphilosophen* in tendency. Bonn was then a center of medical *Naturphilosophie*. Müller later rejected the philosophy in question—how vigorously I need not tell you. But he always remained in spirit, as I have understood from the authorities, in the better sense a distinctly philosophical physiologist. He abandoned speculation, but he did not abandon synthesis. His *Habilitationsschrift* in 1830, at Bonn, related to embryology, which also received other contributions from him. His great work on physiology is a synthetic one. He always viewed his special work in its relations to the whole medical science. His influence was in the direction of unity as well as of thoroughness. Amongst his pupils were Helmholtz, Du Bois Reymond, Schwann and Virchow—all of them men of a distinctly philosophical universality of grasp.

J. L. Schönlein, born in 1793, studied in Würzburg from 1813 to 1816. Here he was under the influence of the *Naturphilosophie*. Later he, too, as I learn from the historians of medicine, achieved his scientific independence. He is called by Haeser the founder of exact modern clinical methods in Germany; and was the center of a great school of medical workers, to which Virchow also later belonged. He was a clinical organizer rather than a productive writer; but the influence of philosophical interests upon his work appears to have been decided.

To pass to another field of scientific work, Von Baer, the embryologist, was a pupil of Döllinger in Würzburg. Döllinger was a prominent medical *Naturphilosoph*. It was he who seems to have first set both Von Baer and Von Baer's contemporary and coworker Pander to work upon embryological researches. Döllinger himself, as *Naturphilosoph*, had been led to work upon comparative anatomy. His merit as the inspirer and teacher of Von Baer is expressly recognized by Franz

Müller in the latter's just quoted "Gesch. d. org. Naturw. im 19ten Jahrh."

Nägeli, the botanist, whose philosophical predispositions were very manifest in all his work, was born in 1817, was for a time under the influence of Oken, heard Hegel in Berlin, soon turned away from the *Naturphilosophie* with a decided sense of disillusionment, contributed largely to science, but remained in spirit a philosopher to the end of his days.

More indirect, but extremely obvious, is the relation of Virchow himself to the *Naturphilosophie*. Born in 1821, and growing up as he did in the generation when the *Naturphilosophie* was generally regarded with disfavor by all the strongest scientific men, Virchow, like Helmholtz, had not first to live through and overcome an adherence to the doctrines of the *Naturphilosophen*. But he too was as full of a philosophical spirit as if he had been a speculative thinker. His essay, "Die Einheitsbestrebungen in der wissenschaftlichen Medecin," belonging to the late forties, is a defense of certain leading ideas which he never could have formulated if he had not come to consciousness under the influence of the philosophical problems of his time. His interesting conception of the relation of medicine to social science, and even to politics, his definition of his own philosophy as "Humanism," his insistence upon the search for unity of knowledge as the justification of all specialism—these are all philosophical notions which one can only understand in their relations to German thought at large. Virchow's frequent return, in his various addresses, to the portrayal of the history and the merits of the controversies of the period of the *Naturphilosophie*, show how much he was dependent for his original inspiration and his spirit upon the issues that the *Naturphilosophie* defined. In what sense does science seek for unity? How is science related to religion, to the humanities, to the social interests of mankind, to the problems of the theory of knowledge? These are problems which Virchow repeatedly faces. His vindication of the right and the duty of special research is a philosophical one. Moreover, he too, as you well know, founds his work as a pathologist upon the leading idea that the study of the *Entwickelungsgeschichte* of tissues, and, in particular, of morbid growths, must be a central task for the pathologist. Experience vindicated the value of this idea. But the history of philosophy had a good deal to do with the importance which the idea had obtained during the time of Virchow's own youthful process of development.

So far for a few examples of tendencies which were in those days quite prevalent. But now for a somewhat more general view. Nobody who takes a broader survey of the history of German scholarship in the second and third and fourth decades of the nineteenth century can fail to see how wide-spread was the influence of what may in general be called the evolutionary idea upon the whole conduct of special research. It makes no difference whether you turn to pathology or to Indo-European philology, to the work of the students of jurisprudence or to that of the comparative embryologists, whether the cell-theory or Bopp's Comparative Grammar is used as your illustration—all sorts of branches of special natural research, outside of physics and chemistry themselves, and especially in Germany, were in those days guided by the idea that the most important aspect of natural objects and processes that could be studied was their historical aspect, their growth, the history of their evolution, unless indeed, as in physics and chemistry, the phenomena presented few or no points

of attack for such a type of research. In my "Spirit of Modern Philosophy," twenty years or so since, I pointed out the meaning and the historical source of this general tendency of German science and scholarship in the period in question. While preparing that book I at one time made for myself a list of those great treatises belonging to the years between 1815 and 1835—treatises issued in Germany, each one of which may be called epoch-marking in its own branch of historical or of more or less definitely evolutionary research. It is a list of notable works, which shows a constant widening and deepening interest in the growth of institutions, civilizations, art, religion, organisms, languages—in short, of whatever lives and can grow.

Now this interest in the evolutionary aspect of things had not been characteristic of the eighteenth-century science. It did not until much later become as prominent in English or in French science as, during the decades in question, it already was in Germany. Its relation during the years after 1815 in Germany to the leading ideas —to the dreams, if you will, of the previous romantic period of the *Naturphilosophie,* is historically obvious. Its relation to the later organization of the general doctrine of evolution is just as obvious. One has, therefore, to give credit to the *Naturphilosophie* for an indirect influence upon the course of the progress of the most various sciences—an influence as salutary as the direct influence of the *Naturphilosophen* had frequently been enervating or confusing. The special worker might well say, like Virchow, "You, the *Naturphilosophie,* were my enemy, from whom I happily escaped. For you counseled dreamy speculation; while I learned to look faithfully through my microscope at the facts as they were." But the *Naturphilosophie,* had it still lived to follow its own indirect influence, might have replied: "Yes, but I dreamed of evolution, and you special workers found it. I viewed the promised land from Pisgah and died. You crossed the Jordan of hard work and entered in."

To drop metaphor, the sober facts are these—facts of some importance in the history of science, although I have no wish to give them any false importance. Some of the most notable scientific discoverers of Germany in the years between 1820 or 1830 and 1860 were men who had been in their youth, sometimes directly, sometimes indirectly, under the influence of the *Naturphilosophie.* With this influence such men had in general learned to quarrel. They consciously turned away from it to special research. But the influence after all left in them a love for the universal, for the connections of things, for reflection upon the meaning of their special researches, for synthesis. And above all, this influence left in them an intense eagerness to study the connected story of the growth of organisms—a sense for the meaning of evolution—a disposition to interpret facts in the light of the growth of organized processes. Herein lay then an instructive although indirect relation between philosophy and science.

In the inorganic sciences, where the evolutionary idea was, at least at that time, and except in geology, out of place, the indirect influence of the *Naturphilosophie* showed itself mainly in a disposition to seek for the unity that binds into one system the various forms of natural energy.

As I before pointed out, the modern theory of the conservation of energy, of the equivalence of various forms of energy, and of the conditions which determine the transformations of energy, is not the product of any one set of motives. It is in fact

a remarkable example of the union of two sets of motives. The whole experience of modern industrial art gave rise to the induction that perpetual motion is in all forms impossible, that all sorts of energy must be paid for if you mean to use them, and that the expenditure of any form of energy takes place in one direction only, or, in other words, that energy will not, so to speak, run up hill without special costs due to the process whereby it is set running up hill. These were practical inductions, forced upon the users of machines by considerations of need, economy and expense. The steam engine especially taught lessons of this sort, and led Carnot to his famous "Reflections on the Motor Power of Heat." Here lay concealed one side of the coming energy theory. In England a similar union of technological and physical research also led to the threshold of the final generalization. But an important part of the theory was due to quite another sort of man, viz., to a medical man, and one who was in spirit a good deal disposed to large syntheses of a type similar to those of the former *Naturphilosophie*. In the early forties, Mayer had his attention called, while he was physician in charge of a ship's company in the tropics, to the fact that the venous and the arterial blood of his patients were not so different from one another in color as they were in a colder climate. This single fact aroused a long series of reflections upon the process of oxidation in its relation to the production of heat in the organism, and then upon the relation of chemical and organic processes in general, and then upon the relations of both to physical processes. Before Mayer returned to Europe, he had his mind full of an universal theory of the relations of the natural energies, organic as well as inorganic. The theory had the advantage over the Schellingian type of theory that it could be brought into exact relations to experience, and so tested. But in its origin it was a theory of a philosophical type such as the older *Naturphilosophie* might have used had it been acquainted with what the science of 1840 knew.

It was the union of philosophical interests and industrial needs that thus gave birth to the modern doctrine of energy. The moral seems to be that one very good foundation for important scientific generalizations lies in bringing into close relations widely philosophical and intensely and imperiously practical human interests. I think that, as the foregoing historical examples show, medicine itself has more than once greatly profited by just such an union. The industrial and the medical arts, if too much oppressed by the mere desire to accommodate themselves to the momentary needs of individual men, tend, when left to themselves, towards a shallow and unprogressive empiricism. Philosophy, by itself, tends, when applied to the subject matter of such arts, to fruitlessly vague dreams. But the union of the industrial or the strictly practical and the philosophical spirit tends to produce men like Virchow, or doctrines like the modern doctrine of energy. Hence I myself heartily welcome the introduction of technological enterprises into modern universities; and I also believe that the useful arts are all the better off for being troubled occasionally, by the neighborhood of philosophy. Philosophy, on the one hand, and the useful arts, on the other, are too often somewhat like the pine and the palm tree of Heine's well-known lyric. They are far apart; but they sometimes long for each other. It is a pity to keep them in such isolation.

IV

But now, finally, what follows from the foregoing historical sketch for our under-

standing of the logic of scientific method? I venture still to add these few summary comments as I close.

Inductive scientific generalizations, in the logically simplest cases, depend upon what Mr. Charles Peirce has defined as the method of taking a "fair sample" of a chosen type of facts. Thus one who samples, to use Mr. Peirce's typical example, a cargo of wheat, by taking samples from various parts of the cargo, carefully selecting the samples so that they shall not tend to represent one part of the cargo only, but *any* part chosen at random, employs essentially the same inductive method which, as I gather from inquiry, Virchow used in reaching the main fundamental generalizations of his cellular pathology. Samples chosen for investigation from a great variety of growths show, both in the case of normal and in the case of morbid tissues, that in the observed samples there is sufficient evidence of the origin of each cell from a previous cell, and evidence too that the tissue is formed of generations of cells whose beginnings, both in the normal and in the morbid growths, lead back to parent cells of certain definable types. This outcome of observation, repeatedly confirmed by samples fairly chosen, that is, by samples chosen from various organisms, from various tissues, and chosen not merely to illustrate the theory, but to represent as well as may be all sorts of growths—this, I say, leads to the *probable* assertion that this kind of origin of tissues is universal, and that one is dealing with a genuine law of nature. The probability of such a generalization can be tested in a more or less exact way, as Peirce has shown, by the principles of the mathematical theory of probabilities. Inductions of this type we may call statistical inductions. They presuppose nothing at the outset as to what laws are present in the world of the facts which are to be sampled. The technique of induction here consists wholly in learning, (1) how to take fair samples of the facts in question, and (2) how to observe these facts accurately and adequately. This kind of induction seems to be especially prominent in the organic sciences. Its logical theory is reducible to the general theory of probability, since fair samples, chosen at random from a collection of objects, tend to agree in their constitution with the average constitution of the whole collection.

But now, as you well know, a great deal of scientific work consists of the forming and testing of hypotheses. In such cases the inductive process is more complex. Peirce defines it first as the process of taking a fair sample from amongst the totality of those consequences which will be true if the hypothesis to be tested is true, and secondly as the process of observing how far these chosen consequences agree with experience. If a given hypothesis, in case it is true, demands, as often happens, countless consequences, you of course can not test all of these consequences, to see if every one of them is true. But you select a fair sample from amongst these consequences, and test each of these selected consequences of the hypothesis. If they agree with experience, the hypothesis is thereby rendered in some degree probable. The technique of induction now involves at least four distinct processes: (1) The choice of a good hypothesis; (2) the computation of certain consequences, all of which must be true if the hypothesis is true; (3) the choice of a fair sample of these consequences for a test; and (4) the actual test of each of these chosen consequences. So far as you make use of this method of induction, you need what is called training in the theory of your topic, that is, training in the art of

deducing the consequences of a given hypothesis. This may involve computations of all degrees of complexity. You also need training in the art of taking a fair sample of consequences for your test; for a given hypothesis may involve numerous consequences that are already known, from previous experience, to be true. And such consequences furnish you with no crucial tests. In case of success, your hypothesis may become very highly probable. But induction never renders it altogether certain.

Classic instances of this method of induction exist in the physical sciences. In the organic sciences the process of testing hypotheses is frequent, but is less highly organized, and generally less exact than in the great cases that occur in the inorganic sciences. No theory of the consequences of any hypothesis in the organic sciences has ever yet reached the degree of precision attained by the kinetic theory of gases, or by the theory of gravitation.

So much for the two great inductive methods, as Peirce defines them. But now does successful scientific method wholly reduce to these two processes, viz., (1) sampling the constitution of classes of phenomena; and (2) sampling the theoretical consequences of hypotheses? Many students of the subject seem to think so. I think that the history of science shows us otherwise.

As a fact, I think that the progress of science largely depends upon still another factor, viz., upon the more or less provisional choice and use of what I have already called, in this paper, leading *ideas*.

A leading idea is, of course, in any given natural science, an hypothesis. But it is an hypothesis which decidedly differs from those hypotheses that you directly test by the observations and experiments of the particular research wherein you are engaged. Unlike them, it is a hypothesis that you use as a guide, or in Kant's phrase, as a regulative principle of your research, even although you do not in general intend directly to test it by your present scientific work. It is usually of too general a nature to be tested by the means at the disposal of your special investigation. Yet it does determine the direction of your labors, and may be highly momentous for you.

Such a leading idea, for instance, is the ordinary hypothesis that even in the most confused or puzzling regions of the natural world law actually reigns, and awaits the coming of the discoverer. We can not say that our science has already so fairly sampled natural phenomena as to have empirically verified this assumption, so as to give it a definite inductive probability. For as a fact, science usually pays small attention to phenomena unless there appears to be a definable prospect of reducing them to some sort of law within a reasonable time; and chaotic natural facts, if there were such, would probably be pretty stubbornly neglected by science, so far as such neglect was possible. On the other hand, the leading idea that law is to be found if you look for it long enough and carefully enough is one of the great motive powers not only of science but of civilization.

It may interest you to know that the modern study of the so-called axioms of geometry, as pursued by the mathematicians themselves, has shown that such principles as the ordinary postulate about the properties of parallel lines (as Euclid defines that postulate) are simply leading ideas. What the text-books of geometry usually assert to be true about the fundamental properties of parallel lines is a principle that is neither self-evident, nor necessarily true, nor even an inductively assured truth of experience. It turns out,

in the light of modern logical mathematical analysis, to be, I say, simply a leading idea, —that is, a principle which we can neither confirm nor refute by any experience now within our range, but which we use and need in geometry precisely because it is so serviceable in simplifying the geometry of the plane.

If I may venture to cite an example from your own science, I should suggest the following: That fundamental principle of Virchow's "Cellular Pathology" which asserted the origin of every cell from a cell was, as I already said, a perfectly straightforward induction, of Peirce's first type, that is, it was a probable assertion of a certain constitution as holding for a whole type of cases—an assertion made simply because this constitution had been observed to hold for a sufficient number of fairly selected samples of the type. But, on the other hand, consider another principle which Virchow asserted already in 1847 or earlier, and which, as I have long been told, has been of the first importance for the whole later development of your science: "We have learned to recognize," says Virchow, "that diseases are not autonomous organisms, that they are no entities that have entered into the body, that they are no parasites which take root in the body, but that they merely show us the course of the vital processes under altered conditions" (*"das sie nur den Ablauf der Lebenserscheinungen unter veränderten Bedingungen darstellen"*).

Now of course I have nothing to suggest regarding the objective truth of this assertion. But I venture to point out that, logically regarded, it is not an hypothesis to be definitely tested by any observation, but is rather an hypothesis of the type of Euclid's postulate about the parallel lines, that is, it is a leading idea. For, on the one hand, how could Virchow regard this principle as one that had been definitely tested, and already confirmed by direct observation and experience at a time when, as in 1847, he was not yet possessed even of his own general principle of a cellular pathology, and when he regarded the whole science of pathology as in its infancy, and the causation of disease as very largely unknown. On the other hand, what experience could one look for that would definitely refute the principle if it were false? Would the experience of such facts as those of your modern bacteriology refute that principle? No, at least so far as I understand the sense of the principle as Virchow stated it in 1847. For when bacteria, or when any of their products or accompaniments came to be recognized either as causing disease, or as affecting the course of disease in any way, it was still open to Virchow to say that the causes thus defined simply constitute these very *veränderte Bedingungen* under which the *Ablauf der Lebenserscheinungen* takes place. In other words, the principle, if understood with sufficient generality, simply asserts that a disease can not occur in an organism without the processes of the disease being themselves alterations of the processes of the organism, and such alterations as the altered conditions, whatever they are, determine. Such a principle, so understood, seems tolerably safe from empirical refutation. It would remain unrefuted, and empirically irrefutable, so far as I can see, even if the devil caused disease. For the devil would then simply be one of the *veränderte Bedingungen*. Thus when the devils on a famous occasion entered, in the tale, into the Gaderene swine, the *Ablauf* of the *Lebenserscheinungen* of the swine was such, under the *veränderte Bedingungen*, that, as we are told, they ran down a steep place into the sea. But I do not see that this just stated pathological postulate of Virchow's need have suffered ship-

wreck, or need even have received any damage, even on this occasion. The devils are indeed represented in the tale as entities that from without entered into the swine, as bullets might have done. But the running down into the sea is *nur der Ablauf der Lebenserscheinungen* of the swine themselves. Let bullets or bacteria, poisons or compressed air, be the *Bedingungen*, the postulate that Virchow states will remain irrefutable, if only it be interpreted to meet the case. For the principle merely says that whatever entity it may be, fire or air or bullet or poison or devil, that affects the organism, the disease is not that entity, but is the changed process of the organism. What then is this hypothesis, this rejection of every external-entity-theory of disease, as the hypothesis appears when Virchow writes these words in 1847? I reply, this is no hypothesis in the stricter sense; that is, it is no trial proposition to be submitted to precise empirical tests. It is, on the contrary, a very precious leading idea. It is equivalent to a resolution to search for the concrete connection between the processes of any disease and the normal process of the organism, so as to find the true unity of the pathological and the normal process through such a search. Without some such leading idea, the cellular pathology itself could never have resulted; because the facts in question would never have been observed. And I suppose that some equivalent leading idea, if not precisely that which Virchow stated in 1847, is just as precious to you to-day in your own pathological work.

The value of such leading ideas for a science lies in the sorts of research that they lead men to undertake, and also in the sorts of work that they discourage. They are, I repeat, regulative principles. Observation does not, at least for the time, either confirm or refute them. But, on the other hand, they awaken interest in vast ranges of observation and experiment, and sustain the patience and enthusiasm of workers through long and baffling investigations. They organize science, keep it in touch with the spirit of the age, keep alive in it the sense of the universal, and assure its service to humanity. Specialism, without leading ideas, remains but a sounding brass and a tinkling cymbal.

The sources of useful leading ideas seem to me to be various. Social, and in particular industrial interests, suggest some of them, as the perennial need of paying the coal-bills for the steam engines suggested, as we have seen, one of the leading ideas which pointed the way towards the modern theory of energy. The comparison of the results of various sciences awakens such leading ideas in various minds. Schleiden set Schwamm searching for the basis of the cell theory in animal tissues. That was the suggestion of an hypothesis in the narrower sense, to be tested. But when the physical sciences set the students of organic science to the work of conceiving organic processes as mechanical in their inmost nature, that was the suggestion of a leading idea.

But another source of such leading ideas has been, upon occasion, philosophy. Philosophy itself might be defined as a systematic scrutiny of leading ideas. It has also proved to be often an inventor and interpreter of such ideas. Its faults in its work have been frequent and obvious. In answer to Dr. Councilman's request I have tried, dispassionately, to point out such faults in the *Naturphilosophie*. It has also been my duty to point out some of the excellencies that went with these defects. The moral of my story is, I suppose, that it is the interaction of various types of human thought and investigation, and not mutual isolation or contempt, which helps us all, while he

does best who works as you do in medicine with the profoundest theoretical problems and the most intensely practical interests at once pressing upon him, with the widest and most philosophical breadth of view, and the most faithful special labor, at once demanding attention.

Josiah Royce

Harvard University

Some Tables of Student Hours of Instruction

In the days of President Dunster, the publications of Harvard University gave the curriculum leading to the first degree in arts in a single sentence thus: "The first year shall teach Rhetoric, second and third years Dialectics, and the fourth year shall add Philosophy." In no such simple form are the requirements for graduation set forth in a modern college catalogue. To determine exactly what studies must and what studies may be included in the college course calls in most cases for much study. To learn even approximately how many undergraduates, or what proportion of the undergraduates, are taking courses in any particular subject is in general impossible from the college catalogue. In some departments, many courses are offered, while few students elect; in other departments, few courses are offered and many students take them. At a few institutions the enrollment figures for all classes are now available in the published reports of the president or other officer, but in most cases one must call on the recording office to obtain such figures.

For the sake of the interest which the comparison of such statistics from many institutions may afford, the following tables have been prepared. They give the registration in the various subjects at eighteen more or less representative American colleges and universities. In the first table the numbers of "student hours of instruction" are given by subjects, while the second table gives the same facts in a form more suitable for comparison of the work of different institutions, since in it all the figures have been reduced to, and are expressed in, percentages. These statistics rest on a semester basis and include in general only undergraduates—candidates for the first degree; accordingly, special students and partial course students and all graduate students, so far as possible, have been omitted. Furthermore, in the cases of the universities, only the college of arts, or the college of letters and science, according as that school of the university is named, has ordinarily been included. Thus, the Columbia statistics refer only to Columbia College, the Yale statistics to Yale College, the Harvard statistics to Harvard College, the Wisconsin statistics to the college of letters and science, etc. It is only fair to state at once, however, that the great diversity in the grouping of the work of the universities in different schools makes the results here given unsatisfactory for comparison in the cases of the universities. One university appears to include all of its undergraduate work in engineering in the college of letters, while a second university includes only a little in that school, and a third none. Other differences of similar sort have been found in comparing the figures from the universities. No such difficulties arise with regard to the statistics of the colleges and it is believed that the tables are entitled to full credence for purposes of comparison so far as all the fourteen or fifteen smaller institutions included are concerned.

The figures have been submitted in most cases by the registrar for the purpose of this paper, but in a few instances they have been compiled from the printed report of the president, dean or registrar.

A "student hour of instruction," as that term is used here, means the taking of a course of one hour per week by one student through one semester. Thus, a class of twenty students taking a three-hours-per-week course in English for two semesters gives 120 student hours of instruction in English. The number of student hours of instruction in any course for any semester is obtained by multiplying the number of students in the course by the number of hours per week which that course counts towards graduation; ordinarily, in a

non-laboratory course, the latter factor is the same as the number of class-room hours per week given to the course; while in laboratory courses, and occasionally in non-laboratory courses, this factor is less than the number of hours given to the class-room exercises of the week. It is believed that this factor has always been used, in the work of these tables, in accordance with the established ruling of the institution concerned.

The subjects have been grouped in three divisions along the lines most generally accepted, if any association of subjects has gained sufficient adoption to entitle it to a claim of general acceptance. The first division includes the foreign languages, together with archeology, philology, comparative literature and "Greek art, etc." The third division includes mathematics and the sciences. The second division includes all other subjects, particularly English, history, philosophy and allied departments. It was found unfeasible to retain in all cases the departmental or subject names used by the various institutions. Consequently, such grouping of departmental titles as seemed feasible has been made. Thus philology is made to include "classical philology" and "comparative philology"; archeology includes "archeology and art"; Romance languages includes "French," "Italian" and "Spanish"; English includes "English composition," "English language" and "English literature"; public speaking includes "oratory" and "elocution"; government includes "modern government," or "politics" and "political science,"—which seems to be used at one institution as including government only and at another as including both economics and government; economics includes "sociology," "economics and sociology," "political economy" and "commercial organization"; philosophy includes "psychology"; Bible includes "Biblical history," "Biblical literature" and "Biblical history and literature"; art includes "the fine arts," "art and archeology" and "graphic art"; drawing includes the work in that subject which seems to be properly supplementary to the department of art, while "mechanical drawing" is included ordinarily under surveying and drawing or mathematics; music includes "musical history"; mathematics includes "applied mathematics" in the case of Leland Stanford Junior University; engineering includes "graphics," "graphics and engineering," "civil engineering," "electrical engineering" and "mechanical engineering"; chemistry includes "chemistry and mineralogy"; zoology includes "entomology and bionomics"; geology includes "geology and mining," "geology and mineralogy," "mineralogy" and "mineralogy and petrography"; physiology and hygiene includes "physiology," "hygiene" and "physiology and histology"; and physical education includes "physical training" and "physical training and personal hygiene,"—the gymnasium-work component of which subject is included in the figures reported from a few institutions, but is omitted by most of them. It is acknowledged that these groupings might be changed on fuller knowledge of the facts of the particular institutions, but the various combinations mentioned may perhaps be regarded suitable and sufficient for the present purpose.

It is to be noted that the Dartmouth figures do not take into account the courses taken by the undergraduates in the professional work of the medical, Thayer and Tuck schools. Similarly, the figures for Cornell include only such work as is taken by arts students, omitting that done by other students in other colleges in that university.

The statistics from the Johns Hopkins University refer to the year 1912–13, but are submitted for this report with the statement that it is believed they are not very unlike those of 1911–12; all the other information in the tables applies to 1911–12 only. The Smith College figures are based on only the first semester of the college year, but one reads in the report from which they are taken that they differ very little for the second semester; accordingly, the same figures are used for both semesters.

The Leland Stanford Junior totals do not include the work done in the medical depart-

TABLE I. *Student Hours of Instruction of College Undergraduates, Semester Basis* 1911–12

	Amherst	Bowdoin	Bryn Mawr	Columbia	Cornell	Dartmouth	Harvard	Johns Hopkins	Mount Holyoke	Oberlin	Princeton	Smith	Leland Stanford	Wellesley	Wesleyan	Williams	Wisconsin	Yale	Oxford Honors Choices
DIV. I. FOREIGN LANGUAGES																			
Semitics	.....	.....	.....	.....	188	.....	291	45	.....	.....	.....	.....	.....	.....	.....	.....	210	.....	Literæ Humaniores, 147; Modern Languages, 11; Oriental Languages, 4.
Egyptology	.....	.....	.....	.....	.....	.....	174	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Sanskrit	.....	.....	.....	.....	.....	12	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Greek	423	321	151	522	424	351	612	129	331	447	1,701	202	571	288	154	675	340	1,470	
Greek Art, etc.	.....	.....	.....	.....	384	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Latin	1,110	543	1,370	1,966	710	1,029	1,158	192	1,635	857	4,076	1,532	1,160	1,047	417	1,429	1,766	2,686	
Philology	.....	.....	.....	.....	.....	.....	18	23	.....	.....	.....	.....	.....	12	.....	.....	.....	.....	
Archeology	.....	.....	96	.....	.....	339	99	24	84	447	.....	4	.....	108	.....	.....	.....	100	
Germanic Languages	1,002	900	404	2,760	2,242	3,057	4,467	470	1,447	2,450	1,971	1,930	2,863	3,329	944	1,906	10,762	2,554	
Romance Languages	1,725	825	706	3,054	2,416	4,437	5,307	427	1,395	1,534	3,429	2,242	2,782	2,760	1,214	2,014	8,384	3,366	
Slavic Languages	.....	.....	.....	.....	.....	.....	267	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Comparative Literature	.....	.....	66	.....	.....	18	1,935	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Totals	4,260	2,580	2,793	8,302	6,364	9,243	14,328	1,310	4,892	5,735	11,177	5,910	7,376	7,544	2,729	6,024	21,462	10,176	162
DIV. II. ENGLISH, HISTORY, ETC.																			
English	2,268	1,832	2,024	7,488	4,027	4,107	7,287	930	4,845	4,990	4,839	3,018	4,917	8,456	1,968	2,282	12,722	7,114	
Public Speaking	345	.....	216	.....	495	1,422	516	.....	.....	348	.....	683	.....	696	64	.....	510	.....	
History	681	1,113	1,082	4,622	2,066	2,793	4,467	381	1,495	1,764	.....	2,106	4,192	2,771	1,528	1,845	7,654	4,854	
History, Pol. and Econ.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8,040	.....	.....	.....	.....	.....	.....	.....	
Government	570	.....	455	1,818	4,028	864	4,161	.....	.....	538	.....	.....	.....	.....	.....	702	2,224	.....	
Economics	423	921	535	1,448	.....	3,666	7,719	432	951	1,769	.....	1,316	3,951	1,641	1,010	1,044	6,978	4,000	
Education	.....	.....	100	.....	575	.....	228	.....	703	507	.....	.....	1,790	1,074	.....	.....	.....	26	
Bibliography	.....	.....	.....	.....	44	.....	.....	.....	.....	30	.....	.....	.....	.....	.....	.....	.....	.....	
Philosophy	798	699	1,208	5,316	1,709	619	3,681	248	945	2,056	2,943	1,896	1,371	2,028	1,123	889	2,930	1,540	
Anthropology	.....	.....	.....	102	.....	.....	648	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	884	
Religion	.....	.....	.....	544	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	105	.....	.....	
Bible	513	.....	297	.....	.....	.....	.....	.....	1,467	1,572	27	820	.....	3,284	.....	.....	.....	82	
Social Ethics	.....	.....	.....	.....	.....	.....	249	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Art	.....	.....	.....	.....	.....	.....	1,266	.....	879	.....	558	1,036	869	878	.....	.....	.....	.....	
Drawing	.....	.....	.....	.....	.....	.....	.....	.....	.....	146	.....	.....	.....	.....	.....	.....	.....	.....	
Architecture	.....	.....	.....	.....	81	.....	438	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Landscape Architecture	.....	.....	.....	.....	.....	.....	24	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Music	215	.....	.....	592	194	93	903	.....	437	359	.....	893	.....	1,218	.....	.....	964	.....	
Art and Music	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	202	
Law	.....	.....	.....	.....	552	.....	.....	.....	.....	.....	.....	.....	2,770	.....	.....	.....	.....	1,798	
Totals	5,813	4,565	5,917	21,930	13,771	13,564	31,587	1,991	11,722	14,079	16,407	11,768	19,860	22,046	5,693	6,867	33,982	20,500	380
DIV. III. SCIENCES																			
Mathematics	1,452	351	216	3,644	2,021	2,788	3,090	473	1,740	1,943	5,038	1,514	4,050	4,126	705	1,921	7,316	1,566	
Surveying and Drawing	.....	66	.....	.....	.....	.....	.....	54	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Engineering	.....	.....	.....	.....	915	912	2,694	.....	.....	.....	3,379	.....	5,725	.....	.....	.....	.....	.....	
History of Science	.....	.....	.....	.....	.....	.....	120	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Astronomy	81	.....	.....	546	.....	144	552	.....	415	42	456	141	.....	378	.....	186	98	.....	
Physics	345	174	501	1,192	1,688	2,457	1,473	375	541	321	3,243	405	1,096	540	387	605	4,388	1,990	
Chemistry	774	516	205	2,736	4,090	1,804	3,648	372	1,122	1,674	2,209	685	2,644	753	1,016	1,071	8,930	1,730	
Biology	1,038	222	607	.....	.....	.....	.....	216	.....	.....	693	.....	.....	.....	1,624	526	3,260	1,072	
Botany	.....	.....	61	470	150	.....	537	.....	359	580	.....	546	587	2,414	.....	.....	.....	.....	
Zoology	.....	.....	.....	832	153	.....	618	.....	927	602	.....	617	1,176	1,488	.....	.....	.....	.....	
Zoology and Botany	.....	.....	.....	.....	.....	2,022	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Geology	150	117	285	600	834	315	789	183	222	456	1,356	116	2,213	816	.....	174	3,550	692	
Mining and Metallurgy	.....	.....	.....	.....	.....	.....	435	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Physiology and Hygiene	.....	114	35	120	.....	105	1,110	.....	255	555	.....	.....	1,180	890	.....	66	768	.....	
Physical Education	311	.....	.....	1,850	.....	.....	.....	.....	.....	706	.....	.....	1,103	.....	.....	.....	.....	.....	
Medicine	.....	.....	.....	.....	532	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Veterinary	.....	.....	.....	.....	18	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Agriculture	.....	.....	.....	.....	1,042	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Totals	4,151	1,560	1,910	11,990	11,443	10,547	15,066	1,673	5,581	6,879	16,374	4,024	19,774	11,405	3,732	4,549	28,310	7,050	113
Grand Totals	14,224	8,705	10,620	42,222	31,578	33,354	60,981	4,974	22,195	26,693	43,958	21,702	47,010	40,995	12,154	17,440	83,754	37,726	655

Modern History, 197; Jurisprudence, 111; Theology, 52; English Literature, 20.

Natural Science, 88; Mathematics, 25.

TABLE II. *Student Hours of Instruction of College Undergraduates Reduced to Percentages* 1911–12

Subject	Amherst	Bowdoin	Bryn Mawr	Columbia	Cornell	Dartmouth	Harvard	Johns Hopkins	Mount Holyoke	Oberlin	Princeton	Smith	Leland Stanford	Wellesley	Wesleyan	Williams	Wisconsin	Yale	Oxford Honors Choices	Average Percentages by Institutions, Oxford omitted
DIV. I. FOREIGN LANGUAGES																				
Semitics	.....	.....	.....	.....	.59	.....	.49	.91	.....	.....	.....	.....	.....	.....	.....	.....	.25	.....		
Egyptology	.....	.....	.....	.....	.....	.....	.29	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
Sanskrit	.....	.....	.....	.....	.....	.04	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
Greek	2.98	3.58	1.42	1.24	1.34	1.05	1.00	2.59	1.49	1.68	3.89	.93	1.21	.70	1.26	3.88	.41	3.91		
Greek Art, etc.	.....	.....	.....	.....	1.22	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
Latin	7.80	6.23	12.89	4.66	2.25	3.08	1.89	3.86	7.38	3.21	9.26	7.06	2.47	2.55	3.43	8.20	2.11	7.14		
Philology	.....	.....	.....	.....	.....	.....	.03	.46	.....	.....	.....	.....	.....	.03	.....	.....	.....	.....		
Archeology	.....	.....	.91	.....	.....	1.02	.16	.48	.38	1.68	.....	.02	.....	.26	.....	.....	.....	.27		
Germanic Languages	7.04	10.35	3.80	6.54	7.10	9.18	7.33	9.45	6.53	9.18	4.49	8.89	6.09	8.12	7.77	10.92	12.85	6.78		
Romance Languages	12.10	9.48	6.65	7.24	7.66	13.28	8.70	8.58	6.28	5.75	7.81	10.34	5.92	6.73	9.99	11.54	10.02	8.84		
Slavic Languages	.....	.....	.....	.....	.....	.....	.44	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
Comparative Literature	.....	.....	.62	.....	.....	.05	3.17	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Literae Humaniores, 22.44; Modern Languages, 1.68; Oriental Languages, .61.	
Totals	29.92	29.64	26.29	19.68	20.16	27.70	23.50	26.33	22.06	21.50	25.45	27.24	15.69	18.39	22.45	34.54	25.64	26.94	24.73	24.50
DIV. II. ENGLISH, HISTORY, ETC.																				
English	15.94	21.05	19.06	17.74	12.75	12.33	11.95	18.70	21.84	18.69	11.01	13.91	10.46	20.63	16.20	13.08	15.20	18.87		
Public Speaking	2.43	.....	2.04	.....	1.57	4.27	.85	.....	.....	1.31	.....	3.15	.....	1.70	.53	.....	.61	.....		
History	4.79	12.78	10.18	10.95	6.54	8.39	7.32	7.66	6.74	6.61	.....	9.71	8.92	6.76	12.58	10.58	9.13	12.88		
History, Pol. and Econ.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18.25	.....	.....	.....	.....	.....	.....	.....		
Government	4.01	.....	4.28	4.31	12.75	2.59	6.82	.....	.....	2.02	.....	.....	.....	.....	.....	4.02	2.65	.....		
Economics	2.98	10.58	5.04	3.43	.....	10.98	12.65	8.68	4.28	6.63	.....	6.07	8.40	4.00	8.31	5.99	8.33	10.61		
Education	.....	.....	.94	.....	1.82	.....	.38	.....	3.16	1.90	.....	.....	3.81	2.62	.....	.....	.....	.07		
Bibliography	.....	.....	.....	.....	.14	.....	.....	.....	.....	.11	.....	.....	.....	.....	.....	.....	.....	.....		
Philosophy	5.61	8.04	11.37	12.59	5.41	1.85	6.03	4.99	4.26	7.70	6.70	8.74	2.92	4.95	9.24	5.10	3.49	4.08		
Anthropology	.....	.....	.....	.24	.....	.....	1.06	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.35		
Religion	.....	.....	.....	1.29	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.60	.....	.....		
Bible	3.61	.....	2.80	.....	.....	.....	.....	.....	6.62	5.88	.06	3.78	.....	8.01	.....	.....	.....	.21		
Social Ethics	.....	.....	.....	.....	.....	.....	.41	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
Art	.....	.....	.....	.....	.....	.....	2.09	.....	3.96	.....	1.27	4.77	1.85	2.14	.....	.....	.....	.....		
Drawing	.....	.....	.....	.....	.....	.....	.....	.....	.....	.55	.....	.....	.....	.....	.....	.....	.....	.....		
Architecture	.....	.....	.....	.....	.25	.....	.72	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
Landscape Architecture	.....	.....	.....	.....	.....	.....	.04	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
Music	1.51	.....	.....	1.39	.61	.28	1.45	.....	1.97	1.34	.....	4.10	.....	2.97	.....	.....	1.15	.....		
Art and Music	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.54		
Law	.....	.....	.....	.....	1.75	.....	.....	.....	.....	.....	.....	.....	5.89	.....	.....	.....	.....	4.77		
Totals	40.88	52.45	55.71	51.94	43.59	40.69	51.77	40.03	52.83	52.74	37.29	54.23	42.25	53.78	46.86	39.37	40.56	54.38	58.02	46.78
DIV. III. SCIENCES																				
Mathematics	10.21	4.03	2.04	8.63	6.41	8.36	5.06	9.51	7.85	7.28	11.46	6.98	8.62	10.07	5.81	11.01	8.73	4.15		
Surveying and Drawing	.....	.76	.....	.....	.....	.....	.....	1.09	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
Engineering	.....	.....	.....	.....	2.90	2.74	4.42	.....	.....	.....	7.69	.....	12.18	.....	.....	.....	.....	.....		
History of Science	.....	.....	.....	.....	.....	.....	.20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
Astronomy	.57	.....	.....	1.29	.....	.43	.91	.....	1.87	.16	1.04	.65	.....	.92	.....	1.07	.11	.....		
Physics	2.43	2.00	4.72	2.82	5.34	7.35	2.41	7.54	2.44	1.20	7.39	1.85	2.33	1.32	3.19	3.47	5.25	5.27		
Chemistry	5.44	5.93	1.93	6.48	12.95	5.41	5.98	7.48	5.05	6.27	5.01	3.16	5.62	1.84	8.33	6.14	10.67	4.59		
Biology	7.30	2.55	5.71	.....	.....	.....	.....	4.34	.....	.....	1.58	.....	.....	.....	13.36	3.02	3.89	2.84		
Botany	.....	.....	.58	1.11	.45	.....	.88	.....	1.62	2.17	.....	2.52	1.25	5.89	.....	.....	.....	.....		
Zoology	.....	.....	.....	1.97	.45	.....	1.01	.....	4.14	2.25	.....	2.84	2.50	3.63	.....	.....	.....	.....		
Zoology and Botany	.....	.....	.....	.....	.....	6.05	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
Geology	1.06	1.34	2.69	1.42	2.64	.95	1.33	3.68	1.00	1.71	3.09	.53	4.71	1.99	.....	1.00	4.24	1.83		
Mining and Metallurgy	.....	.....	.....	.....	.....	.....	.72	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
Physiology and Hygiene	.....	1.30	.33	.28	.....	.32	1.81	.....	1.14	2.08	.....	.....	2.51	2.17	.....	.38	.91	.....		
Physical Education	2.19	.....	.....	4.38	.....	.....	.....	.....	.....	2.64	.....	.....	2.34	.....	.....	.....	.....	.....		
Medicine	.....	.....	.....	.....	1.68	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
Veterinary	.....	.....	.....	.....	.06	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
Agriculture	.....	.....	.....	.....	3.31	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
Totals	29.20	17.91	18.00	28.38	36.25	31.61	24.73	33.64	25.11	25.76	37.26	18.53	42.06	27.83	30.69	26.09	33.80	18.68	17.25	28.72
Grand Totals	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Modern History, 30.08; Jurisprudence, 16.95; Theology, 7.94; English Literature, 3.05.

Natural Science, 13.43; Mathematics, 3.82.

ment; and they contain results for both undergraduate and graduate students—contrary to the plan of using the figures for undergraduates only.

The statistics from the University of Wisconsin should be viewed in the light of the following statements from Dean Birge: "The college of letters and science teaches all the language, science and mathematics for the colleges of engineering and agriculture. This gives us a great many students in the elementary classes who take their advanced work in other colleges. This fact would make the advanced work relatively smaller than it would be if the college of letters and science alone were concerned. It increases the registration in modern languages, English, chemistry, physics and mathematics very considerably." The figures for the first semester are used, with permission, for both semesters in the case of Wisconsin.

The numbers of those who entered for the different final honors schools in 1912 at the University of Oxford have been included in the tables. Perhaps much more value would attach to statistics which should include the "pass" men also; but figures showing the lines along which the choices of the more earnest students at this great English university fall are regarded of at least sufficient interest to warrant their inclusion here.

In the order of the relative amount of work done in the foreign languages, the seventeen American institutions considered rank, according to this table, for the year in question thus: (1) Williams, (2) Amherst, (3) Bowdoin, (4) Dartmouth, (5) Smith, (6) Yale, (7) Johns Hopkins, (8) Bryn Mawr, (9) Wisconsin, (10) Princeton, (11) Harvard, (12) Wesleyan, (13) Mount Holyoke, (14) Oberlin, (15) Cornell, (16) Columbia, (17) Wellesley and (18) Leland Stanford Junior, with the Oxford honors men standing between Princeton and Harvard.

Similarly, the order as to the amount of work done in the subjects of the second division (English, history, philosophy, etc.) is as follows: (1) Bryn Mawr, (2) Yale, (3) Smith, (4) Wellesley, (5) Mount Holyoke, (6) Oberlin, (7) Bowdoin, (8) Columbia, (9) Harvard, and, with a long interval, (10) Wesleyan, (11) Cornell, (12) Leland Stanford Junior, (13) Amherst, (14) Dartmouth, (15) Wisconsin, (16) Johns Hopkins, (17) Williams and (18) Princeton, with the Oxford honors men preceding Bryn Mawr.

Again, the order for the division of science stands thus: (1) Leland Stanford Junior, (2) Princeton, (3) Cornell, (4) Wisconsin, (5) Johns Hopkins, (6) Dartmouth, (7) Wesleyan, (8) Amherst, (9) Columbia, (10) Wellesley, (11) Williams, (12) Oberlin, (13) Mount Holyoke, (14) Harvard, (15) Yale, (16) Smith, (17) Bryn Mawr, (18) Bowdoin, with the Oxford honors men last of all.

In general, the eastern institutions show a greater amount of work in the foreign languages than the western, while the western show much larger numbers in science. In the second division the line between the east and the west is not nearly so clear, while Yale and the colleges for women stand together at the head of the list. Amherst and Dartmouth stand much closer to each other in the distribution of their work along these three lines than do any other two of the group which includes them and Bowdoin, Wesleyan and Williams. Johns Hopkins and Wisconsin present results which are very similar; and so do Smith College and Yale College, while Bryn Mawr stands very close to both.

One hesitates to try to account for these differences of distribution of work in our colleges. Probably the presence or absence of required courses, the economic and social factors of the time and place, the influence of women in coeducational institutions, the countless personal equations and all those tendencies, accidental, traditional and historical, which enter in the making of a curriculum and the creation of the student sentiment towards it—all these and many more must be the reasons which together determine these things. Into these questions the statistician makes no attempt to enter. The tables are presented simply as shedding a bit

of light of some interest on the great subject of American collegiate education.

FREDERICK C. FERRY

SCIENTIFIC NOTES AND NEWS

THE statue of Lord Kelvin, erected in Kelvin Grove Park, Glasgow, was unveiled on October 8. Mr. Augustine Birrell, rector of Glasgow University, made the address, and at the luncheon which followed an address was made by Mr. Arthur Balfour. The statue, which is of bronze, is the work of A. McF. Shannan.

COLONEL GEO. W. GOETHALS, chairman of the Isthmian Canal Commission and chief engineer of the Panama Canal, has accepted the honorary presidency of the International Engineering Congress and will preside over the general session to be held in San Francisco, September 20–25, 1915.

PROFESSOR THEOBALD SMITH, of Harvard University, has accepted membership on an International Committee with Professor Gaffky, of Berlin, and Professor Calmette, of Lille, to award in 1914 the first Emil Chr. Hansen Prize for researches in medical microbiology.

THE Warren triennial prize for 1913, amounting to $500, has been awarded to Dr. Arrigo Visentini, instructor in pathologic anatomy in the Royal University, Pavia, Italy, for his essay entitled, "Function of the Pancreas and its Relation to the Pathogenesis of Diabetes."

AT its last meeting the Rumford Committee of the American Academy made the following appropriations: To Professor W. O. Sawtelle, of Haverford College, $300, in addition to a former appropriation, in aid of his research on "The spectra of light from the spark of an oscillatory discharge"; to Professor G. N. Lewis, of the University of California, $300, in addition to a former appropriation, in aid of his researches on the "Free energy changes in chemical reactions"; to Professor H. N. Davis, of Harvard University, $200, in aid of his various thermodynamical researches.

DR. CARL VOEGTLIN, associate professor of pharmacology in the Johns Hopkins University, has been appointed professor of pharmacology in the hygienic laboratory, U. S. Public Health Service, to succeed Professor Reid Hunt, now head of the department of pharmacology at Harvard University.

PRIVATDOZENT DR. CARL TIGERSTEDT, of the physiological institute of the University of Helsingfors, Finland, recently appointed as research associate of the Carnegie Institution of Washington, is spending the winter in the Nutrition Laboratory in Boston.

ALBERT W. WHITNEY has resigned his position of associate professor of insurance and mathematices in the University of California to become assistant actuary in the Insurance Department of the State of New York.

PROFESSOR GAFFKY, director of the Institute for Infectious Diseases, Berlin, retired from his position on October 1. His successor will probably be Professor Loeffler, of Greifswald.

PROFESSOR A. OBRECHT has been appointed director of the Santiago Observatory in succession to the late Dr. Ristenpart.

DR. ROGER CROISSANT, Paris, is visiting the United States, to study the system of training nurses with a view of organizing similar work in France.

DR. JOSEF SCHUMPETER, professor of political economy in the University of Graz, Austria, has been named as the Austrian exchange professor for the winter semester of 1913–14 at Columbia University. He is a graduate of the University of Vienna in 1906, and studied later in Berlin and England, in which latter country he remained until 1908. Dr. Schumpeter writes and speaks the English language perfectly.

DR. RHODA ERDMANN, of the department of protozoology of the Berlin Institute for Infectious Diseases, has been appointed Seesel research fellow in zoology at Yale University, to enable her to study Professor Woodruff's pedigreed race of *Paramœcium*.

DR. BURT G. WILDER, emeritus professor of neurology and vertebrate zoology in Cornell University, will reside hereafter in Brookline, Mass., the home of his boyhood. His address

this winter is 60 Park St. For the present he has given up scientific research in order to complete his "Records and Recollections of the Civil War," based upon his daily letters, which were all preserved.

Professor W. M. Davis, of Harvard University, lectured on "The Lessons of the Colorado Canyon," at Denison University, October 6; at Ohio Wesleyan University, October 7; at Ohio State University, October 8; at State Normal College, Ypsilanti, October 10, and at the University of Rochester, October 13. He also spoke on "Glacial Erosion in Montana" at Ohio Wesleyan; on "The Bearing of Physiography on the Theories of Coral Reefs," at Columbus, and on "Experiences of an Exchange Professor at Berlin and Paris," at Ypsilanti.

"The Physical Basis and Determination of Sex" was the subject of an illustrated address given on October 18 by Associate Professor H. H. Newman, of the department of zoology of the University of Chicago, at Fullerton Hall, Art Institute of Chicago, under the auspices of the Field Museum of Natural History.

Dr. Hideyo Noguchi gave a demonstration at a meeting of the Royal Society of Medicine, London, on October 13, of the results of his recent investigations, most of them carried out at the Rockefeller Institute of Medical Research, of which he is an associate. He showed pure cultures of various pathogenic and saprophytic spirochetes, demonstrated the presence of *Treponema pallidum* in the brain in cases of general paralysis, and showed experimental general paralysis in rabbits. He also gave a demonstration of his recent cultural studies of the virus of rabies.

Mr. Clayton D. Mell, of the U. S. Forest Service, sailed on October 16 from New York for British Guiana to inspect greenheart timber to be used in the construction of docks and other marine works for the Panama Canal.

Mr. R. A. Rowley, assistant professor of geology in the University of the Philippines, has recently returned from an expedition to the northern part of the Island of Palawan, and is engaged in working up a suite of rocks from that little known region.

It is stated in *Nature* that Major Barrett-Hamilton, accompanied by Mr. Stammwitz, one of the taxidermists on the staff of the British Museum (Nat. His.), has sailed in a whaler for South Georgia, on a mission from the Colonial Office, to report on the whaling stations leased by the British government to a Norwegian firm.

A branch laboratory of the United States Bureau of Mines has been established in Morse Hall, Cornell University, in connection with the department of chemistry. Investigations will be made of problems related to the manufacture of brass and other alloys of copper by Dr. H. W. Gillett and Dr. J. M. Lohr under the direction of Dr. Charles Lathrop Parsons, chief mineral chemist of the Bureau of Mines, and Professor Bancroft.

The sixty-seventh anniversary of Ether Day was celebrated at the Massachusetts General Hospital, Boston, on October 16, when the principal address was delivered by Dr. Milton J. Rosenau.

We learn from *Nature* that at the recent International Congress of Pharmacy held at the Hague, a proposal to form an international pharmacopœial bureau was discussed, and a commission was appointed to consider the question, and to submit to the International Pharmaceutical Federation at an early date a scheme for the establishment of such a bureau. The commission is composed of seven members, representing, respectively, Great Britain, the United States, Germany, France, Holland, Belgium and Switzerland; most of the members are associated with the revision of their national pharmacopœias, the English representative being Professor H. G. Greenish, joint editor of the "British Pharmacopœia," and the American, Professor J. P. Remington, editor of the "United States Pharmacopœia." Among the duties of such a bureau as that proposed would be the collection and examination of all literature relating to pharmacopœial revision and the experimental investigation of new drugs and preparations, and no doubt the

influence of the bureau would tend to encourage the work already commenced in the direction of the unification of pharmacopœias.

AT the request and with the cooperation of the Massachusetts Society for the Prevention of Cruelty to Animals, the faculty of medicine of Harvard University offers a course of free public lectures, to be given at the Medical School, on Sunday afternoons, beginning October 5 and ending December 21, 1913. The lectures begin at four o'clock.

October 5, "The Protection of Domesticated Animals," Professor Veranus A. Moore, of Cornell University.

October 12, "Our Increased Knowledge concerning the Nature of Animal Diseases," Dr. George W. Pope, of the Bureau of Animal Industry, Washington.

October 19, "The Dangers of Live-stock Traffic," Professor Karl F. Meyer, of Philadelphia.

October 26, "Stable Ventilation" (with lantern-slide demonstration), Professor James B. Page, of Amherst.

November 2, "Modern Operative Methods applied to Veterinary Surgery," Professor Harvey Cushing, of Boston.

November 9, "The Relation between Human and Animal Tuberculosis," Professor Theobald Smith, of Boston.

November 16, "Protection of Animals from Infective Diseases," Dr. Charles H. Higgins, of Ottawa.

November 23, "The Diseases and Care of Poultry and the Pig," Dr. Austin Peters, of Boston.

November 30, "The Diseases and Care of the Dog and the Cat," Dr. Arthur W. May, of Boston.

December 7, "The Diseases and Care of the Horse and the Cow," Dr. F. H. Osgood, of Boston.

December 14, "Rabies and Glanders," Dr. Langdon Frothingham, of Boston.

December 21, "The Relationship between Human and Animal Diseases in the Tropics," Professor R. P. Strong, of Boston.

THE Vienna correspondent of the British Medical *Journal* writes that the events of the past year have forced the senate of the University of Vienna to the unwelcome conclusion that the university no longer occupies the position it once held in the esteem of foreign scientific men. This has been proved by the fact that the well-known physiological chemist, Professor Abderhalden, refused the directorship of the chemical institute left vacant by the departure of Professor Ludwig, whilst the post of director of the medical clinic, formerly held by Professor von Noorden, has likewise been declined by Professor His, of Berlin. These refusals, which were totally unexpected and caused very great surprise, are in themselves sufficient to prove that the university is to blame for this loss of prestige; whilst the resignation of two such eminent German scientific men as Professor von Strümpell and von Noorden, both men in the prime of life, seems to point to the existence of some grave cause for dissatisfaction on the part of foreign professors. It is said that the matter has provoked much comment among the medical profession in Austria, which is beginning to express its disapproval of a régime that has had the effect of driving strangers away from Vienna, instead of attracting them to it. It is evident that some reformation of the existing conditions is needed, and it rests with the profession to see that this is properly carried out. In the meantime, temporary substitutes have been appointed to vacant posts in the persons of Professor Nauthner to the chemical institute and Professor Salomon to von Noorden's clinic. Public opinion is said to be in favor of the reservation of these posts in future for Austrians but religion, race and politics play as important a part in their selection as scientific attainments.

STATISTICS of the electrical machinery, apparatus and supplies industry in the United States for 1909 are presented in detail in a bulletin soon to be issued by the Bureau of the Census. It was prepared under the supervision of W. M. Steuart, chief statistician for manufactures. This industry includes the manufacture of the machines and appliances used in the generation, transmission and utilization of electric energy, together with most of the parts, accessories and supplies for them. It does not include, however, the production of poles, whether of wood, iron or steel; nor

does it include the manufacture of glass and porcelain ware made expressly for electrical purposes, that of bare iron and copper wire, or any of the group of electrochemical and electrometallurgical products. The total number of establishments in the United States in 1909 engaged in the manufacture of electrical machinery, apparatus and supplies, was 1,009. The total number of persons engaged in the industry was 105,600, of whom 102,950 were wage earners. The total capital employed was $267,844,432, and the total value of products was $221,308,563. The industry in 1909 was largely centralized in the six states of New York, Pennsylvania, New Jersey, Massachusetts, Illinois and Ohio. These states together reported 83.9 per cent. of the total average number of wage earners, 82.6 per cent. of the total value of products and 83.1 per cent. of the total value added by manufacture.

UNIVERSITY AND EDUCATIONAL NEWS

The Graduate College of Princeton University was formally dedicated on October 22. Professor Andrew F. West, dean of the graduate school, made the principal address, his subject being "The Household of Knowledge." Addresses of congratulation were made by Dr. Alois Riehl, professor and former rector in the University of Berlin; Dr. Arthur Shipley, master of Christ's College, Cambridge; Dr. Arthur Denis Godley, fellow of Magdalen College and public orator in the University of Oxford; M. Emile Boutroux, honorary professor in the University of Paris and president of the Foundation Thiers, and by President Nicholas Murray Butler, of Columbia University. The Cleveland Memorial Tower was then presented by Mr. Richard V. Lindabury, president of the Cleveland Monument Association, and accepted on behalf of the university by President John Grier Hibben. A memorial address on "Grover Cleveland" was then made by ex-President William Howard Taft. Earlier in the week the foreign guests gave public lectures, the subject of Dr. Shipley's address being "The Origin of Life."

Dr. Christian B. Holmes has been appointed dean of the medical department of the University of Cincinnati, succeeding Dr. Paul G. Woolley.

At the University of California, Frank LeRoy Peterson has been appointed assistant professor of farm mechanics, and Dr. Max Morse, instructor in physiology.

Charles T. Kirk, Ph.D. (Wisconsin, '11), has been appointed professor of geology in the University of New Mexico.

Miss Fanny C. Gates, formerly head of the department of physics at Goucher College, has been appointed dean of women and professor of mental and physical hygiene in Grinnell College.

Mr. George R. Johnstone, A.B. (Illinois, '13), has been appointed instructor in botany at the Michigan Agricultural College, making four instructors in addition to professor and assistant professor, who give the full time to instruction in botany, with two research assistants giving a quarter of their time respectively to plant pathology and plant physiology. Five hundred and twenty-one students have registered for work in the botanical department, being an increase of twenty-five per cent. over last year.

Mr. William C. Willard, C.E., M.Sc., Lehigh University, has been appointed assistant professor of railway engineering at McGill University, Montreal.

At Birmingham University Dr. F. C. Lee has been nominated to the chair of civil engineering vacated by Professor S. M. Dixon. Professor P. F. Frankland, F.R.S., has been elected dean of the faculty of science in succession to Professor Dixon.

DISCUSSION AND CORRESPONDENCE

COMMENTS ON PROFESSOR BOLLEY'S ARTICLE ON CEREAL CROPPING

It is now rather late to refer to Professor Bolley's article on "Cereal Cropping," published in Science on August 22, but I can not refrain from calling in question his statements in regard to the deterioration in the quality of wheat grown on soils which are "exhausted"

or "sick." The question of yield I shall not touch upon further than to say that the only instances which have come under my observation where a total crop failure has occurred (and which could not easily be accounted for by weather conditions or attacks of recognized diseases, insects, etc.) have been on *new* lands.

It is certainly a common idea of millers that the quality of wheat has steadily deteriorated in most localities where it has been grown for many years; but one can not be expected to receive as conclusive a popular opinion unsupported by evidence. As Professor Bolley says, "In late years there has been a vast amount of talk about cereal crop deterioration" both in regard to quantity and quality. But "a vast amount of talk" is one thing, and scientific proof quite another.

He asks:

> Why is it that fertile wheat lands do not produce wheat of reasonably normal quality?

Further on he refers to

> the evident rapid deterioration of the quality of grain which invariably accompanies the first few years of cropping upon the new land areas. Indeed, in some of the newer great wheat-producing regions the most fertile new lands do not produce wheat now either in yield per acre or in quality similar to that which adjoining lands did when first put under wheat culture. Commonly, the new lands at first, even though of light texture, and of low chemical fertility, are expected and usually do produce grain above the ordinary average as to quality in color, form and milling texture, but, very soon, the yield per acre and the quality drops off to such extent that the millers complain bitterly.

Again he refers to the "low yield and invariable deficiency in quality." Further on occur these words:

> In spite of these directions [by our best agriculturists] the wheat soon becomes soft and shows all of the peculiar characteristics which we find named in the literature of the chemical laboratory, or in the milling tests of wheat as previously indicated, "white-bellied," "piebald," or shrivelled, bleached and blistered, "black-pointed," in fact all the qualities of deteriorated grain.

Where farm manure is applied, he says:

> There may be increased yields, with vital deterioration in quality of seed produced.

I am not sure of the exact meaning of the word *vital* in this case, but presume that it means *hereditary*.

I hope I am not one of those who are "too cocksure of their scientific principles," but I certainly disagree with Professor Bolley and venture to bring forward a little evidence for my views.

It is a fact that "piebald" or "yellowberry" wheat, which is counted of poor quality by millers because of its softness, is often produced (in Canada) on newly cleared land. Some years ago when searching for very soft (*i. e.*, low grade) wheat in Manitoba, I was obliged to go to new land, on which the first crop was being raised. There I secured an extremely poor (though plump) specimen of Red Fife wheat, so soft that an ordinary miller would almost refuse to buy it. That this is a common occurrence is proved by a large number of examples, and I venture to say that every careful student of wheat in Canada will agree with me on this point. I have never seen any wheat grown on old land, in the great spring-wheat areas of Canada, as soft as some of the samples from new lands. Without being able to quote specific proofs, I believe it is true that these new lands gradually by cultivation become altered in their texture so as to produce wheat of harder grade, *i. e.*, superior wheat from a miller's point of view. In other words the actual process is one of gradual improvement and not of degeneration. I believe that the popular idea of "degeneration" (which is prevalent in eastern Canada) is due, in so far as there is any truth in it, to the farmers growing inferior varieties, which are supposed to give larger yields than Red Fife when grown on partially exhausted soil.

That wheat is not growing poorer in quality on this farm or in the Ottawa Valley is clearly shown by the excellent samples produced this season, and indeed in most seasons since 1902, which was a soft wheat year. If there is any tendency to gradual change it seems to be in the direction of improvement. I fully expect,

however, that when a suitable season for the production of soft wheat occurs again, the crop will be quite as soft as in 1902.

A careful series of milling and baking tests of wheat from highly fertilized and exhausted soils (or soils on which wheat had been grown repeatedly) was made by me a few years ago. These results have not yet been published, but they prove, in so far as one series of tests can prove anything, that there is no essential difference in flour quality between samples of wheat raised under the two extreme conditions. I have not seen any trustworthy evidence whatever that wheat grown on poor soil (whether "exhausted" or "sick") is inferior for milling and baking purposes to that grown under more favorable conditions, except as regards plumpness, and even there I am not at all sure that the smaller crop from poor soils is as a rule distinctly less plump. I suspect that the lower yield, which is, of course, obtained, is due essentially to a smaller number of kernels rather than to imperfect development of them.

I hope that Professor Bolley will find time to give to the public some of the evidence on which his statements are based, especially the milling and baking tests, and some instances of "vital deterioration in quality of seed," due to manuring.

Chas. E. Saunders

Experimental Farm,
Ottawa, Canada,
October 8, 1913

"QUITE A FEW"

To the Editor of Science: The criticism of T. G. Dabney, in Science of September 5, of the phrase "quite a few," used by Professor Bolley in his paper in Science of July 11, is calculated to excite a surprise among his readers equal, probably, to that which Mr. Dabney himself feels towards Professor Bolley. But "quite a few" conveyed Professor Bolley's meaning perfectly, and, for myself, I can not think of a satisfactory equivalent that could have been substituted. *Quite a number* is a phrase sufficiently commonplace, probably—if it had been used—to have escaped Mr. Dabney's eagle eye, but is no more precise. What more can an essayist ask, and what can a reasonable critic object to, if a writing is so worded—albeit slightly colloquial—that its meaning is taken instantly?

If purists are to pounce on all our colloqualisms whenever they happen to be found isuing "from a learned teacher, in a scientific disquisition in a scientific journal" and articles are to be reduced to the cast-iron requirements of such critics, then the readers thereof will lose some valuable time. For it takes time to get the meaning of a thoroughgoing pedant. What should be said, for instance, of the phrase "pretty nearly," which is *pretty* common, I believe, among good writers? "Pretty" refers to the looks of a thing. Would anybody say that "pretty nearly" must be taken to mean *nearly pretty?* Then there is "Now then," a favorite phrase of lecturers introductory to the elucidation of some point just previously dated. If it means *now,* Mr. Dabney might say, it can not mean *then.* Take the word "scientist," which is admittedly a barbarism and one that has been fought against for forty years, yet sticks in the language like a burr, because of its usefulness—what are we going to do with that? Why, use it, of course, and snap our fingers at etymology and consistency, for it takes the place of three words and can not possibly be misunderstood.

The fact is, the English language defies argument. Vagrant words, phrases and sentences, illogical and intolerable at first, are every now and then creeping into usage and refusing to be turned out. In the beginning they may excite loathing, then they are simply frowned on and avoided whenever possible—though often through considerable circumlocution—but in the end they become "good English." And the chances are that some day we are astonished to find some of them in Shakespeare—like "a bum bailiff," for example, which he who looks for will find there.

The meaning to be conveyed is the desideratum above everything else. That may be developed with much labor, in sentences always capable of parsing and always logical, or the writer may show a little more elasticity

of style and be just as well, if not better, understood. He will also be more agreeable to "quite a few" of SCIENCE's readers I have no doubt, among whom is

HENRY K. WHITE

CATONSVILLE, MARYLAND,
September 25, 1913

SCIENTIFIC BOOKS

A Biological Survey of the Waters of Woods Hole and Vicinity. Section I., Physical and Zoological, by FRANCIS B. SUMNER, RAYMOND C. OSBURN and LEON J. COLE. Section II., Botanical, by BRADLEY M. DAVIS. Section III., A Catalogue of the Marine Fauna, by FRANCIS B. SUMNER, RAYMOND C. OSBURN and LEON J. COLE. Section IV., A Catalogue of the Marine Flora, by BRADLEY M. DAVIS. Department of Commerce and Labor. Bulletin of the Bureau of Fisheries, Vol. XXXI., 1911. Washington, Government Printing Office. 1913.

This bulletin is issued in two parts, each a separate volume; Part I., 544 pages, of which 54 contain introductory explanations and physical data, the remainder giving the results of the dredging operations carried on by the bureau, supplemented by some observations on conditions in shallower water, where dredging was not necessary. In this part 274 charts and maps are included. The second part contains 316 pages, numbered continuously with the first part. It consists of catalogues of the marine animals and plants, with localities, etc., bibliographies of works referring to the region in question, and ends with what appears to be a complete index. The present notes refer to the botanical parts, which occupy 147 pages, as against 620 pages for the zoological; but some reference is necessary to the introductory part.

The region under consideration includes Vineyard Sound and Buzzards Bay; the main body of the information on which this work is based was obtained by dredgings in the years 1903, 1904 and 1905, and a few in 1907, from the government steamers, *Fish Hawk*, *Phalarope* and *Blue Wing*. In all 458 stations were dredged, of which a list is given, showing date, location, depth and character of bottom. Charts 225 to 227 also show these data graphically. At each station a record was kept of the species brought up by the dredge, so that the data as to distribution may be considered as fairly complete. The result of this, as regards 38 species of algæ, is shown on charts, identical outline charts of the region, one for each species, with a star showing each station where the species was found. No verbal description can express as clearly as do these charts the area inhabited by a species, and their value is especially shown when one compares the eight similar charts in the zoological section, showing, not distribution of species, but temperature, density, etc. Compare, for instance, chart 228, *Chætomorpha melagonium*, a northern plant, occurring here only in the colder waters by Gay Head and Cuttyhunk; chart 237, *Laminaria digitata*, also northern, about Gay Head only; chart 241, *Griffithsia Bornetiana*, almost entirely in the warmer waters near shore; chart 242, *Griffithsia tenuis*, a common plant of the Mediterranean and Bermuda, here reaching its northern limit, and here recorded only in the extreme northern portion of the chart, where shallow water and distance from the open sea give a higher temperature than in the more southern part of the bay or in the sound.[1]

With these chart 261, *Grinnellia americana*, is in strong contrast, showing an almost universal distribution for this beautiful and characteristically American species.

The dredgings on which the charts were based were all made in the months of July, August and September; that different results would have been obtained by dredgings in other months is quite possible, especially as regards annuals, but probably the difference would be less than what is found between tide marks, or just below low-water mark; at such

[1] *G. tenuis* also occurs just east of the region represented in the charts, but only in such bodies of water as Waquoit Bay, which are very shallow, connected with the sea by a narrow channel, and in which in summer the temperature of the water is quite high.

stations in practically all temperate regions a large number of species appear, often abundantly, in late winter and early spring, only to disappear before the midsummer flora is established. This deficiency in data for other than the summer months is in part compensated for by a careful study which Dr. Davis has made of a very limited region, "Spindle Rocks," continuing over a period of fifteen months, after which the rocks were removed in connection with a widening of the ship channel. The eight charts given show zones of growth about each rock, and the appearance, maximum and disappearance of the various species of algæ.

Section IV., list of the marine algæ, is intended to include all species whose occurrence in the Woods Hole region is properly vouched for, including many forms not noted in Section II. Details of distribution, exact localities for rarer forms, dredging stations, seasonal occurrence, references to publications and to exsiccatæ, with synonyms, make this section very complete. The total number of species and the proportions of the different classes are as follows:

Cyanophyceæ	37
Chlorophyceæ	48
Phæophyceæ	66
Rhodophyceæ	89
Total	240

The Woods Hole region has had prominence in the marine algology of New England since the publication of Farlow's list of 1873.[2]

In addition to the investigations of the Fish Commission and its successors, of which the work now under consideration is the latest result, the Woods Hole Marine Biological Laboratory has maintained a summer school here for over thirty years, and the records and herbarium of the laboratory have been utilized in making up this list, which may be considered as approximating completeness nearly enough to justify drawing some general conclusions. Into these conclusions Dr. Davis has gone in some detail; and as to the general character of the flora of this region, the older hypothesis seems justified, that Cape Cod is a relatively sharp boundary line between a subarctic flora, inhabiting the shores north, and a warm-water flora extending south; but with isolated colonies of northern plants in the south, of southern plants in the north.[3]

Dr. Davis's comments on the influence of tides, currents, etc., seem to be well reasoned out and conservative.

The present notes give of course a very incomplete idea of the fullness of the work, which is noteworthy also as the first American attempt to represent the distribution of algæ graphically, rather than by description; indeed the writer can not recall any European work of the same character. Rosenvinge[4] in the first part of his treatise on the algæ of Denmark has given a long list of dredgings, with data of depth, bottom, etc., but there is no indication that any graphic representation is planned. Something resembling this has occasionally been attempted in regard to flowering plants, as for instance by Fernald,[5] Stone,[6] but in these the shading or dotting indicates an area, not a station. The charts for Spindle Rocks are practically unique by their exactness

[2] W. G. Farlow, "List of the Seaweeds or Marine Algæ of the South Coast of New England," Report of U. S. Commission of Fish and Fisheries for 1871–72 (1873), pp. 281–294.

[3] The distinction of an arctic flora on one side of Cape Cod and a warmer flora on the other requires some modification if exactness is wanted. The writer's observations have shown that at Eastham and Welfleet, 25 miles north of Woods Hole, the Massachusetts Bay shore of the cape has a summer flora practically the same as that of the shore of Buzzards Bay. More observations are needed, but it is probable that the flora on both shores of the cape is much the same.

[4] L. Kolderup Rosenvinge, "The Marine Algæ of Denmark, Contributions to their Natural History," *Kgl. Dansk. Vidensk. Selsk. Skrifter*, 7 Raekke, Vol. VII., No. 1. Kobehavn, 1909.

[5] M. L. Fernald, "An Expedition to Newfoundland and Labrador," *Rhodora*, Vol. XIII., p. 109, 1911.

[6] Witmer Stone, "The Plants of Southern New Jersey," Annual Report of the New Jersey State Museum, 1910 (1911).

and their completeness through the year. Considerable attention is given to the matter of "formations" and "associations," as is the custom nowadays in works treating of distribution; it may be a question how far subdivision should be carried in this matter, and whether it is wise to refer to the "*Nemalion* association," "*Dasya* association" and the like, to indicate that a single species grows plentifully in certain localities, without, as far as stated by the author, admixture of any other plant. While much attention is paid to the habitats of the different species, favorable and unfavorable conditions, epiphytes, etc., the word "ecology" is generally conspicuous by its absence; this is to the writer a good sign, as authors who most enjoy using it seem often to be persons with a distaste or contempt for systematic botany, and the systematic botanist has learned to be somewhat cautious in accepting the names used for the plants making up their "associations," etc. The case is stated very compactly in a footnote to a recent paper by Tidestrom.[7]

While there will always be differences of opinion as to the limitations of species, etc., the writer, who is fairly familiar with the New England marine flora, has not found anything to indicate an error in determination in Dr. Davis's list.

While this work is by far the most complete study of the marine flora of any limited region of this continent, it leaves plenty of questions for further study. Among them the writer would suggest as specially interesting the matter of the different range in latitude on the two sides of the Atlantic, of a species occurring on both sides. The occurrence in the Woods Hole region of many Mediterranean species, but the absence of others associated with them in Europe, was long ago pointed out. While this is not taken up by Dr. Davis, it would seem to the writer that it may be due to the much greater range of temperature at Woods Hole, as indicated by the charts, etc.; a Mediterranean annual demanding a high summer temperature, but passing the winter in the spore state, would find no difficulty in living here; while it would be impossible to acclimate an alga requiring a temperature of at least 40° Fahr. throughout the year. But some other cause must be found in the case of a species like *Hypnea musciformis*, abundant and luxuriant at Woods Hole, but not reaching to the English Channel; while *Dictyota dichotoma*, at its best on the English coast, has not been found with us north of North Carolina.

Botanists who desire uniformity of nomenclature will be glad to see that the international rules, as adopted at the Vienna Congress of 1905, are here followed,[8] and it is a matter for congratulation that so careful and thorough a work as Dr. Davis's has been brought out in so good shape as a government publication.

FRANK S. COLLINS
NORTH EASTHAM, MASS.

A Bibliography of the Tunicata, 1469–1910. By JOHN HOPKINS, F.L.S., F.G.S., F.Z.S., etc., Secretary of the Ray Society. Printed for the Ray Society and sold by Dulau & Co., Ltd., 37 Soho Square, London, West, dated 1913.

The author prepared a portion of this bibliography, dealing with titles up to the year 1870, in connection with his preparation for

[7] "Much argument ecological falls of its own weight when the entities considered are not known to the observers." Ivar Tidestrom, "Notes on Vol. XV., p. 104, 1913.

[8] The results of the Brussels Congress of 1910 were not published at the time Dr. Davis's manuscript was accepted by the government; under the rule that the names of Nostocaceæ heterocysteæ and Nostocaceæ homocysteæ date, respectively, from the "Revision" of Bornet & Flahault, and the "Monographie" of Gomont, a few names of authors, given in parenthesis by Dr. Davis, would be omitted, but no generic or specific names would be changed. It is possible that under a strict construction of the Vienna rules the name of *Griffithsia Bornetiana* may have to be given up; but as the few writers who have proposed a substitute use a name certainly unjustified by the same rules, Dr. Davis has done well to retain, in company with all other American algologists, the specific name given by Farlow.

publication of Alder & Hancock's "British Tunicata." He has since completed it through the year 1910. He has added many titles to Herdmann's bibliographic list in his *Challenger* reports, which has been the standard bibliography for the Tunicata.

The bibliography is in the form of an author's index with full titles, with page references, and often with brief note as to contents. There are included not only works which deal exclusively or mainly with the Tunicata, as indicated in their titles, but very many works in which the reference to the Tunicata is not the main theme, general text-books being included in the list. Of course, no such list can possibly be entirely complete, but in this instance it is a remarkably full one and will be of great value to students of the group.

In several weeks' use of the bibliography the reviewer has noticed no inaccuracies and no omissions of any moment. It is a little unfortunate that about a tenth of the titles are placed in a supplementary list.

Maynard M. Metcalf

Oberlin, Ohio,
October 1, 1913

The Earth: Its Genesis and Evolution Considered in the Light of the Most Recent Scientific Research. By A. T. Swaine. London.

Worthless is a very strong adjective to apply to a book which is almost a model in paper, typography and illustration. Yet just what is the value of a book whose author believes that vital force produces matter (p. 72), that thus the earth is slowly growing larger (p. 263), that the great cycles of sedimentation correspond to a filling up of the great ocean depths, a straw-colored siliceous ooze below 3,000 fathoms and red clays corresponding to the basal quartzites and red beds (p. 20), that up to the close of the Paleozoic the light and heat energy of the sun had not been experienced on earth (pp. 144–151), but that an increase in temperature of the earth's crust in cycles was due to igneous activity and outflow of heat from the interior, which evaporated a large amount of the ocean (pp. 89, 95, 109, 174, 183, 193)? Compared with these heresies, the theory that sedimentary rocks are fused sediments (p. 54), that erosion and conglomerates are largely due to the wash of the evaporated ocean condensing again (p. 95) with the tidal waves caused by earth movement paroxysms (pp. 186, 213), the explanation of transgressive formations (p. 95), of laterite (p. 199) and of drumlins (p. 245) are but minor. The book shows, however, a wide acquaintance with recent and the best geological literature, though it is curious in a book that dwells so much on geologic cycles of sedimentation that no mention seems to be made of Newberry or Schuchert. It contains a mass of geological fact mixed with the author's unique views put in an interesting way.

Conceivably, it might be of use to give to a rather advanced student, inclined to swallow what he reads too easily, as an emetic, asking him to show why the facts advanced by the author do not support his theories.

Alfred C. Lane

SCIENTIFIC JOURNALS AND ARTICLES

The first number of the new *Journal of Agricultural Research* published by the U. S. Department of Agriculture was issued October 10. It consists of eighty-seven pages of letterpress and line drawings and five plates, including one color plate. The articles in the first number are:

"*Citrus ichangensis*, a Promising, Hardy, New Species from Southwestern China and Assam."

"*Cysticercus ovis*, the Cause of Tapeworm Cysts in Mutton."

"The Serpentine Leaf-Miner."

In the introduction, written by Dr. B. T. Galloway, assistant secretary, the purposes of the journal are explained as follows: "The recent advances in the theory and practise of agriculture have come almost entirely from scientific research applied to agricultural problems. Accumulated results of centuries of painstaking studies have been drawn upon, and it has become evident that further improvement in agriculture calls for continued investigation of the most accurate and thorough nature. The first recognition of the economic value of progress in these investigations as well as the initial application of theories to practical prob-

lems comes usually from specialists. Indeed, only in rare instances is the significance of the results of scientific research apparent to farmers, since newly discovered facts are seldom directly applicable to agricultural conditions. The suggestive or the indirect value of reports of new work is usually of paramount economic importance; it is the purpose of the *Journal of Agricultural Research*, therefore, to record investigations bearing directly or indirectly upon economic conditions of agriculture." According to the foreword the journal for the first few issues will contain papers from the Department of Agriculture only. The later numbers, however, will probably include articles prepared and submitted by investigators in the state agricultural colleges and experiment stations. The book is highly technical in character and will not be circulated except among scientific specialists.

OCEANOGRAPHIC CRUISES OF THE U. S. FISHERIES SCHOONER "GRAMPUS" 1912–1913

IN the advance of the modern science of oceanography the coastal waters of the eastern seaboard of the United States have received little attention. But the introduction of new fishery methods, and the frequent reports of a diminution of food fishes along our coast add an economic to the purely scientific need for a close study of the physical features, and plankton, of our waters, such as has long been prosecuted in the North Sea by the nations bordering upon it. A beginning has been made along these lines by the U. S. Bureau of Fisheries, with the cooperation of the Museum of Comparative Zoology. And during the past two summers the Fisheries schooner *Grampus* has been detailed, in my charge, for oceanographic cruises which have so far extended from Nova Scotia to Chesapeake Bay, a brief outline of which is given here. In both years Mr. W. W. Welsh, of the bureau, has acted as my assistant.

In a sailing vessel, which the *Grampus* is primarily in spite of a small auxiliary gasoline engine, oceanographic work is necessarily carried on under difficulties. But there was no steamer available. And fortunately we have enjoyed such exceptionally fine weather on both cruises that we worked to better advantage than might have been expected. Such operations as require the vessel to be stationary for any length of time, for example current measurements, were usually performed from a dory at anchor, though occasionally, if the sea was too rough, we anchored the vessel herself for this purpose. For hoisting purposes a gasoline winch was installed on deck. The equipment of the *Grampus* consisted, in 1912, of Negretti and Zambra reversing deep-sea thermometers, a Sigsbee and a stopcock water bottle; an Ekman current meter, a closing net for horizontal towing, described elsewhere,[1] quantitative nets of the Hensen pattern, a variety of ordinary tow nets, large and small, of various grades of silk, and an eight-foot beam trawl.

In 1913 we added a second current meter, two more stopcock water-bottles, a Helgoland "shear board" tow net, which proved to be the most effective of our nets, a three-foot tow net of the *Michael Sars* pattern and a Lucas sounding machine. On the other hand, we discarded the Sigsbee water bottle, which proved unreliable, and substituted an otter trawl for the beam trawl, a change which proved very advantageous.

In 1912 our cruise lasted from July 8 until August 31. We chose the Gulf of Maine as our first field of work partly because of its important fisheries, partly because it was nearly virgin ground so far as sub-surface temperatures, salinities and plankton were concerned, but chiefly because, being a partially isolated area, a comparatively complete survey could be made in the time at our disposal. The stations were planned to include Massachusetts Bay, the deep basin off Cape Ann and Cape Cod, the coastal waters and off-shore banks along the coast of Maine, and a line from Cape Elizabeth to Cape Sable, while a week was spent trawling in and near Casco Bay in cooperation with the Harpswell

[1] *Int. Rev. Hydrobiol. Hydrogr.*, 5: p. 576, 1913.

Marine Laboratory. During the cruise forty-six off-shore stations were occupied, at which 130 tows were made with the various nets; quantitative hauls were made at sixteen stations; the dredge or trawl used at fourteen; serial temperatures were taken at thirty-nine, bottom, intermediate and surface water samples at 37, while 38 current measurements were made. The surface temperature was recorded hourly, and the color of the sea noted by the Forel scale.

On our return to port the salinities of the water samples were obtained by titration with nitrate of silver, the use of floating hydrometers having been abandoned as wholly unreliable.

In November, 1912, operations were resumed on the steamer *Blue Wing,* which acted as tender to the *Grampus* during her fish-cultural operations of the winter. By the courtesy of the Bureau of Fisheries I was enabled to make stations on the *Blue Wing* bi-monthly until April, 1913, in Massachusetts Bay, taking the usual serial temperatures, serial water samples and tows. And during March, April and May, 1913, this work was greatly advanced by Mr. W. W. Welsh, of the Bureau of Fisheries, who took temperatures, water samples and surface tows at numerous stations between Cape Ann and Boon Island, while investigating the spawning habits of the haddock.

We laid out a more ambitious program for our summer cruise in 1913 than in the preceding year, planning to cover the cool coastal water between the coast and the Gulf stream, from Cape Cod to the mouth of Chesapeake Bay, besides repeating, in a general way, our stations of 1912 in the Gulf of Maine. The object of the latter part of the work was, of course, to trace the changes which might take place there from year to year.

On July 7, the *Grampus,* again in my charge, sailed southward from Gloucester. And we were now able to work in much greater comfort than before, an excellent laboratory having been constructed on board during the winter. Our course took us to the western edge of Georges Bank, where we made our second station, thence directly to the edge of the Gulf stream south of Nantucket Shoals Light Ship. We then proceeded southwestward along the coast in a zigzag course, occupying a station every 45 miles or so, and running three sections across the coastal bank to the Gulf stream over the continental slope. On July 24 we reached the Chesapeake, and anchored in Norfolk to refit.

During this part of the cruise three stations were devoted to current measurements, off Long Island, Cape May and Chincoteague, observations being taken hourly, at surface and bottom, for six hours at each station. The first was timed to include parts of both flood- and ebb-tides, the last two together covered an entire flood and nearly an entire ebb.

We left Norfolk July 29, reached Gloucester August 4, and put to sea again for the Gulf of Maine on August 9. We now ran from Cape Ann to Cape Sable, and besides making stations en route, turned aside to visit Jeffreys Bank and the deep trough off Platt's Bank. We then turned northward, crossing the mouth of the Bay of Fundy, and followed the coast back to Gloucester, where we arrived on August 15. During the summer's cruise complete oceanographic observations, including serial temperatures and serial water samples, were taken at 50 stations. And thanks to our ample supply of water bottles, water samples were taken at from 3 to 5 levels at every station. One hundred and sixty-five tows were made with the various plankton nets, including 15 hauls with the quantitative net, the latter all in the Gulf of Maine, and the otter trawl was used at 10 stations. It may be of interest to note that the distance traveled was about 2,100 miles.

The plankton collections gathered during 1912 and 1913 are very extensive, and as varied as the large ocean area traversed would suggest, fish fry and eggs, copepods, hyperiid amphipods, schizopods, sagittæ, pteropods, medusæ and diatoms being especially well represented. And the oceano-

graphic data afford a fairly comprehensive survey, for the summer months. As yet our winter data are confined to Massachusetts Bay, and the region just north of Cape Ann, but it is proposed to continue the work at other seasons in future years. The reports on the oceanography, with preliminary accounts of the plankton, are being prepared in the Museum of Comparative Zoology, those for the summer of 1912 being now in press. And the more important groups of pelagic organisms have been distributed to specialists who have undertaken the task of reporting on them.

It would be premature to discuss the scientific results of the cruises here. But passing notice may be called to our demonstration of the fact, long ago suspected by Verrill, that the low surface temperatures of the northeastern part of the Gulf of Maine do not indicate the direct influence of an Arctic current, as has so often been suggested, but are merely the evidence of the strong tidal currents, which cause a more or less complete vertical mixing of the water. Where the gulf is coldest on the surface, it is warmest at the bottom, depth for depth, and *vice versa*. This process reaches its extreme in the Grand Menan Channel, and on German Bank, where the physical characters of the water are practically uniform from surface to bottom. Mention has already been made in the daily press of our discovery of extensive beds of the sea scallop (*Pecten magellanicus*) off the coasts of New York, New Jersey and Maryland. And this promises a new fishery of such importance that the *Grampus* was dispatched southward once more, on August 20, 1913, in charge of Mr. W. W. Welsh, for a two weeks' survey of the beds.

HENRY B. BIGELOW

HARVARD UNIVERSITY

SPECIAL ARTICLES

ECTO-PARASITES OF THE MONKEYS, APES AND MAN

FOR several years I have been urging the thesis that the host distribution of the wingless, permanent ecto-parasites of birds and mammals is governed more by the genetic relationships of the hosts than by their geographic range, or by any other ecologic conditions. In numerous papers, and particularly in a recent[1] one surveying all the known records of the occurrence of Mallophaga on birds, I have offered evidence to support this thesis.

Now, if this contention is sound, the converse of the statement is also true. That is, the kinds (genus, species, etc.) of permanent ecto-parasites found on birds and mammals will indicate in some measure the genetic relationships of the hosts. If, for example, ornithologists have before their eyes certain birds of doubtful relationships, as the hoatzins of South America, or the whole family of owls, they may well pay respectful attention to the kinds of ecto-parasites harbored by these hosts. I have, indeed, pointed out, in the paper just referred to, some suggestive specific cases of this sort.

The wingless, permanent ecto-parasites of birds and mammals are of two groups, namely, the biting lice, Mallophaga, feeding on the feathers and hair, and the sucking lice, Anoplura, feeding on blood. Certain mites (Acarina) may perhaps also be assigned to this category of permanent wingless parasites, but the fleas can not be, for they hop on and off their host, and all their immature life is non-parasitic and wholly apart from their future hosts. The Mallophaga, of which nearly 2,000 species are now known, occur chiefly on birds, while the Anoplura, of which less than 100 are known so far, are confined to mammals.

As my own study of these ecto-parasites has been almost exclusively restricted to the Mallophaga I have not been able to illustrate or bolster up my thesis with many examples derived from conditions among the mammals, but the recent careful work of Fahrenholz (Hanover) and Neumann (Toulouse) on the determination and distribution of certain genera and species of Anoplura makes it possible to point out an especially interesting case of host and parasitic relations which is

[1] "Distribution and Species-Forming of Ecto-Parasites," *Amer. Nat.*, Vol. 47, pp. 129–158, March, 1913.

highly pertinent to the thesis and its converse or corollary, as worded above. This case is that of the sucking lice (Pediculidæ) of man, the anthropoid apes and the tailed monkeys. As no biting lice (Mallophaga) have been found on man, nor on any anthropoid, and only two species, so far, on the lower monkeys, no evidence from their distribution can be derived to confirm or contradict the evidence from the occurrence of the Pediculines.

The situation is this. Sucking lice of species representing two genera, *Pediculus* and *Phthirius,* occur on man. Of the second genus but one species is known, and this is confined exclusively to *Homo.* Of the other, *Pediculus,* six species (perhaps five and a variety) are known of which two (or perhaps, as Neumann holds, one and a well-marked variety) occur on man and only on man, while one is found, and exclusively, on the chimpanzee, another on the gibbons (two species of gibbons), and two on monkeys of an American tailed genus, *Ateles.* On the other tailed monkeys are found several Pediculine species of two distinct genera, *Pedicinus* and *Phthirpedecinus.*

It is gratifying—to the upholder of my thesis—to find man and his cousins, the anthropoid apes, harboring and really characterized by parasites of such near relationships, while when the leap from the anthropoid to the lower monkeys is made—a leap notoriously greater, from a genetic point of view, than that from man to the anthropoids—the parasites are found to be of other genera. Only the *Pediculus* species on *Ateles* seems to be a disturbing exception. But it is precisely the monkey genus *Ateles* which offers a special taxonomic problem to students of the primates. Friedenthal (of serum precipitins fame) has affirmed that on a basis of blood and hair comparison *Ateles* shows unmistakable differences from other tailed monkeys, and resemblances with the anthropoids, and he suggests that in *Ateles* we should see monkeys that, in a certain sense, replace, in the new world, the anthropoids.

The above is the situation as Fahrenholz works it out. Neumann believes that the typical, man-infesting parasite species, *Pediculus capitis,* should include not only the other man-infesting form, *P. corporis,* but also perhaps one of the *Ateles*-infesting forms (*P. consobrinus*). And he is inclined to credit *Pediculus capitis* with a tendency to pass from man to man-apes and monkeys in menageries, and to persist on these new hosts. If *capitis* can do this, then that in itself is a curiously strong indication of the genetic affinities of these various hosts, because both the Mallophaga and Anoplura are curiously sensitive to differences in host blood or host hair and feathers. I have often become, in the course of collection, the temporary host of various bird- and mammal-infesting Mallophaga, but these parasites all seemed as anxious to escape as I was to have them. And they did escape; or, if they did not, they died in a few hours. There is, indeed, an extraordinarily exact fitting of parasite to host in the case of Mallophaga and Anoplura. It is hard to understand of just what details this fitting consists, beyond such more obvious, and insufficient, ones, as number and shape of claws, number and character of clinging spine-hairs, etc. The essential fitting is far more subtle. It is a fitting to the host's physiology as well as to its epidermal structures.

Anyway, Neumann has not known all the cases of the taking of *Pediculus* specimens from the man-apes and from *Ateles,* and some of these cases are beyond the explanation of casual straggling in menageries. For some of the ape hosts were not in menageries.

There is no doubt that man is host to certain permanent, wingless ecto-parasites which find their closest relatives in parasites of the man-apes and of a problematic lower monkey. And this evidence from commonness of parasites adds itself to the already acquired great mass of other evidence from conditions of structure, blood serum reactions, crystallizable proteins (hemoglobins), and the rest, that bind us so unescapably in close genetic relationship with the anthropoids.

Vernon L. Kellogg

Stanford University,
California